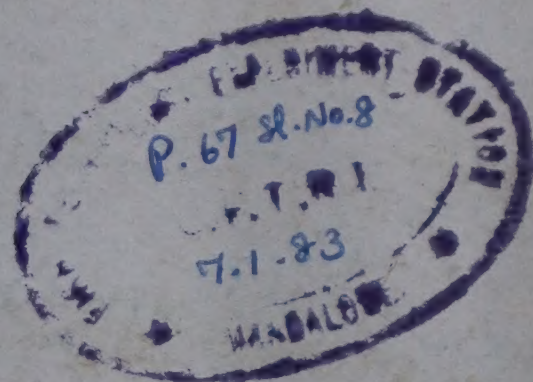


FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS



INDO-PACIFIC FISHERY COMMISSION PROCEEDINGS

18th Session

Manila, Philippines

8-17 March 1978

SECTION III

SYMPOSIUM ON FISH UTILIZATION TECHNOLOGY AND MARKETING
IN THE IPFC REGION

IPFC Secretariat, FAO Regional Office
for Asia and the Far East

Bangkok

1978

**With the Compliments
of the
Director
of the
Bureau of Fisheries
and Aquatic Resources**

P.O. Box 623 Manila, Philippines
4th Floor Arcadia Bldg., Quezon Ave.
Quezon City
Telephone: 96-54-98



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS



INDO-PACIFIC FISHERY COMMISSION
PROCEEDINGS

18th Session

Manila, Philippines

8-17 March 1978

SECTION III

SYMPOSIUM ON FISH UTILIZATION TECHNOLOGY AND MARKETING
IN THE IPFC REGION

IPFC Secretariat, FAO Regional Office
for Asia and the Far East

Bangkok

1978

III

CONTENTS

SESSION I – BACKGROUND AND STATUS OF THE FISH PROCESSING INDUSTRIES OF IPFC COUNTRIES	1
SESSION II – FRESH FISH HANDLING AND DISTRIBUTION	127
SESSION III – FISH PROCESSING	235
SESSION IV – FISH MARKETING AND QUALITY ASSURANCE	411
SESSION V – BY-PRODUCTS FROM MARINE RESOURCES AND WASTE UTILIZATION IN THE FISHING INDUSTRY	487
SESSION VI – FORUM ON EXTENSION SERVICES AND TRAINING PROGRAMMES	607
AUTHOR INDEX	681
SUBJECT INDEX	689
INDEX OF FISH NAMES	693

PREFACE

This volume contains all the papers submitted to the Symposium on Fish Utilization Technology and Marketing in the IPFC Region, held in conjunction with the 18th Session of the Indo-Pacific Fishery Commission in Manila, Philippines, from 8 to 11 March 1978. The contribution of eighty papers was a significant indication of the interest in the Symposium subjects within the Indo-Pacific Region. The collected papers, which have been edited since their presentation, will serve as a record of the present stage of development and transfer of fish technology within the region. Many of the research papers will also be valuable in pointing towards new directions in product development and quality improvement.

The Symposium was divided into six sessions on the following topics:

- Session I — Background and status of the fish processing industries of IPFC countries
- Session II — Fresh fish handling and distribution
- Session III — Fish processing
- Session IV — Fish marketing and quality assurance
- Session V — By-Products from marine resources and waste utilization in the fishing industry
- Session VI — Forum on extension services and training programmes

The report of the discussions, conclusions and recommendations is contained in Section I of the report of the 18th Session of IPFC.

Bibliographic entry:

Indo-Pacific Fishery Commission, Manila,
Philippines, 8-17 March 1978 (1978)
Bangkok, IPFC, 704 p.
Proceedings [of the] 18th session [of the]
Section 3. Symposium on Fish Utilization
Technology and Marketing in the IPFC Region

Fish handling. Fishery products. Processing.
Preservation. Transportation. Storage.
Quality control. Marketing. IPFC.

SESSION

I

SESSION I

BACKGROUND AND STATUS OF THE FISH PROCESSING INDUSTRIES OF IPFC COUNTRIES

CONTENTS

POST-HARVEST TECHNOLOGY OF THE ARTISANAL FISHERIES IN INDONESIA by R. Moeljanto	2
PROCESSING OF TRADITIONAL FISH PRODUCTS IN MALAYSIA WITH SPECIAL REFERENCE TO THE STATE OF TRENGGANU by Wan Johari bin Wan Draud	7
IN SEARCH OF APPROPRIATE FISH-PROCESSING TECHNIQUES FOR INDONESIA by S. Ilyas	12
STATUS AND PROSPECTS OF THE FISH PROCESSING INDUSTRY IN THE PHILIPPINES by Gloria Guevara	23
METHODS FOR PROCESSING AND DISTRIBUTION OF FISH AND FISHERY PRODUCTS IN THE PHILIPPINES by F. Pili and Flor Abella	30
MARINE PRODUCTS PROCESSING INDUSTRY IN INDIA: ITS GROWTH AND FUTURE PROSPECTS by R. Venkataraman and K. Devadasan	38
THE FISH PROCESSING INDUSTRY IN PENINSULAR MALAYSIA by Mohd. Ismail Abdullah and Ahmed Zaharudin Idrus	45
FISHMEAL PROCESSING: STATUS AND PROSPECTS IN MALAYSIA by Ahmad Zahrudin Idrus, Wan Rahimah and Jainudin Abdullah	61
FISH PROCESSING INDUSTRY IN INDIA by K.K.P. Menon	73
PRESERVATION AND TRANSPORTATION OF FISH IN BANGLADESH by M. Shahidullah	81
A PRELIMINARY SURVEY OF THE PRAWN TRAWLING INDUSTRY IN SABAH AND ITS NON-COMMERCIAL FISH CATCH by P.J.I. Snell	86
CURRENT STATUS OF THE FISH PROCESSING INDUSTRY IN THAILAND by B. Saisithi	101
FISH UTILIZATION AND MARKETING IN THE IPFC REGION by E.C. Sison and I.F. Tanudra	105

POST-HARVEST TECHNOLOGY OF THE ARTISANAL FISHERIES IN INDONESIA

by

R. Moeljanto
Research Institute of Fishery Technology
Jakarta, Indonesia

Abstract

Fishery development in Indonesia is aimed at increasing fish consumption and fishermen's income as well as higher foreign exchange earnings. Because more than 90 percent of the total catch is produced by artisanal fishermen, more attention should be paid to rationalization of fishery activities, i.e., fishing efforts, handling of fresh fish and processing and marketing of fresh and processed fishery products. Improved post-harvest technology practices should be applied to produce fish of better quality, this will give a higher income for the fishermen and higher fish consumption. Better results can be achieved through cooperation with the Fishery Cooperatives. Government supervision is required because small-scale fishermen lack the skill, capital and the proper facilities needed to develop the artisanal fisheries. Commercial fisheries can help the fishermen by absorbing their excess catch especially during peak fishing seasons, by distributing good quality ice directly to the fishermen and they could also teach the fishermen how to handle the catch properly. To increase fresh fish consumption, efforts should also be made to encourage people to eat more fish and to introduce new fishery commodities. Most important of all is the need to find new markets to accommodate the increasing fish production.

INTRODUCTION

Fish production in Indonesia has increased from 1 277 512 tonnes in 1973 to 1 448 000 tonnes in 1976. However, annual production is still far below the three million tons which would reflect a 30 kg *per caput* fish consumption compared with the present 10 kg *per caput*. The 1 448 000 tonnes of fish production consists of 1 043 tonnes of marine fish and 405 000 tonnes of freshwater fish. Of the 948 000 tonnes of marine fish caught in 1974, 828 228 tonnes were pelagic fish and the main species were scad (layang), Indo-Pacific mackerel (kem-bung), Spanish mackerel (tenggiri), oil sardine (Lemuru), anchovy (teri) and trevallies (selar).

Java, with more than 60 percent of the total population, is the main market for fresh and cured fishery products. Most of the catch is still preserved by traditional processing methods, mainly salting and boiling. Because of traditional processing methods and simple marketing systems there are always problems in the utilization of the excess catch.

Fisheries development is based mainly on the artisanal fisheries because most of the catch (more than 90 percent) is caught by artisanal fishermen. Because of this the Indonesian Government is trying to improve the living standards of the small-scale fishermen, without neglecting the quality of the catch. Fishery Cooperatives have an important role to play in this programme. Commercial fishing companies can also help by absorbing the excess catch of the artisanal fishermen and by distributing ice.

As in most other developing countries, an awareness of quality is generally lacking. Without proper attention to post-harvest technology it is impossible to produce high quality fresh and processed fish. It is pointless to catch more fish without improving and adding to the handling and marketing facilities. To achieve this goal experiments and research on post-harvest technology are needed in cooperation with the Research Institute of Fishery Technology. Extension and demonstration activities are also important.

PRESENT SITUATION

Production of fresh fish is either for export or for domestic consumption; this includes fresh fish as raw material for further processing. The catching, handling and marketing of fish for export presents no significant

problems because all efforts are directed to produce good quality finished products. But if the raw material comes from the artisanal fishermen there is usually a significant percentage of waste due to poor handling and limited handling facilities. The handling of fresh fish has not improved significantly although facilities for landing, auction and marketing have been introduced. For example, in the Bali strait, the oil sardine has been caught in large quantities (67 115 tonnes in 1976) since the introduction of purse seine nets and although the catch has increased significantly, processing facilities have remained the same. A few years ago the excess catch was cured as salted fish but today salting has almost been abandoned because the cost of producing salt fish has increased and there is tough competition from better quality salted fish from outside Java. According to the Manager of a Fishery Cooperative almost 30 percent of the daily catch of the cooperative fishermen has to be reduced to fish meal.

The problems of the fresh fish industry are more pronounced when the goal of increased fish consumption is considered against the background of excess catches that cannot be utilized at the landing places. This situation is caused by many related factors some of which are: fishing centres are usually far from consumption areas; lack of proper transport facilities; the shelf-life of fishery products is limited; and other restrictions often found in the developing countries (i.e., in most cases no ice is available or is expensive—U.S.\$ 0.20/kg). As a result, excess catches have to be salted as this is the only means of preserving the fish. In South Sumatra for instance where the freshwater fish harvest is large, there is a freshwater fish known locally as 'lais' (*Cryptopterus* sp.). In 1975, this fish formed 13.5 percent of the total catch of 66 090 tonnes. This fish is smoked and the conversion value from fresh fish to smoked fish is very high; in 1975 the price of fresh fish was about Rp. 300-350/kg (U.S.\$ 0.68/kg) while the price of the smoked fish was as high as Rp. 2 500/kg (u.S.\$ 6.40/kg).

POSSIBILITIES FOR INCREASING FRESH FISH CONSUMPTION

More than 60 percent of the Indonesian fish catch is salted since this is the only way of curing the fish. The actual consumption of fresh fish is low. Boiled fish is also very popular, especially in West Java, but here again only a small amount of the fish is eaten at one time due to the high salt content.

From the available data, fresh fish consumption seems to be increasing every year. This may be caused, in part, by higher average incomes and increased fish production. The introduction of ready-to-serve products will probably be used as one of the possible outlets since a suitable raw material is available. In the east of Indonesia, where more than 100 large shrimp trawlers operate, thousands of tonnes of by-catch are not utilized properly. If this fish is processed into minced fish it can be used as raw material for many seafood specialties such as fish balls, fish burgers and fish sausage.

Fish balls are very popular in the big cities of Java. These specialties are becoming so popular in Jakarta, Bogor and Bandung that several species of pelagic fish, Spanish mackerel, and golog-golok (*Chirocentrus dorab*) and rock fish, ekor kuning (*Caesio erythrogaster*), are becoming more and more expensive. Fish sausage is also becoming more popular though still in a limited way. Other specialties, such as battered shrimp and fish burgers, show prospects for further development. To develop new markets for these ready-to-serve products, efforts to promote the new commodities and trials to establish which species of fish, or mixtures of fish, will produce the best quality minced fish, should be made with its low fat content and creamy white flesh, shrimp by-catch should be suitable for frozen minced fish or even dried fish meat powder.

Freshwater fish consumption is still limited except in West Java and South Sumatra. However, most of the catch is consumed in salted form because fresh fish have a limited shelf-life and because icing is not practised. Since chilling can extend the shelf-life of fish by up to two week or more, freshwater fish, if iced properly and promptly, can be transported further, fresh fish consumption is expected to increase if ice is used.

In the important consumer areas of Jakarta, West Java, South Kalimantan and South Sumatra, where live freshwater fish fetch highprices, a centralized live fish terminal might be a possibility to increase fresh fish consumption by supplying consumers with quality live fish. In Jakarta, a plan has been formulated to build a central freshwater fish terminal, with fish stalls at every local community market, to serve the Jakarta population with live fish and to accommodate shipments of freshwater fish from West Java.

From several limited consumer tests, it has been found that fish consumption can be increased through a better distribution chain. Consumers are usually willing to pay higher prices if there is enough variety of good quality fresh fish. Even if they had never seen or tasted a new species of fish, they said that they liked it (*Tilapia nilotica*, nila) and would buy it. By developing the marketing of the existing species, as well as introducing new species, fresh fish consumption can be increased and the fishermen can receive a higher income.

DEVELOPMENT OF NEW MARKET AND COMMODITIES

Java is the main market for traditionally processed fishery products and, because fish consumption is still low, more fish is needed. Artisanal fishermen, with bases along the northern coast of Java, now have to go farther and farther to find new fishing grounds and they need large fishing boats. In this case, Fishery Cooperatives can help the fishermen by providing credit to buy larger fishing boats and fishing gear.

Because the storage life of fresh fish is limited to about two weeks, efforts have to be made so that the fish reaches the consumer in a fresh condition. If the distance and the time of the catch, and the time taken to reach the consumer is more than two weeks, a possible alternative is to freeze the catch on board or at the fishing ground, and transport it by refrigerated fish carrier. There are many international hotels in Java and there are cold stores in almost every provincial capital, so there are facilities to produce frozen fish (as fillets or whole fish) and shellfish. Transportation of frozen fish will not present a problem because most of the big fishing companies have refrigerated fish carriers and they are accustomed to sending their fish to be marketed in Java.

The introduction of new seafood specialties, for example molluscs, has not been carried out on a commercial scale. There is a large resource of clams, rock oysters, mussels, and others, which is virtually untapped; of course they have been exploited by local fishermen but only on a limited scale due to lack of promotion and market. Salted or dried molluscs are very expensive, and the export of frozen scallops and clams has been started though on a limited scale.

THE ROLE OF FISHERY COOPERATIVES

Although Fishery Cooperatives are not as successful as they should be, efforts are being made to improve and develop their functions and their capabilities. Small-scale fishermen will then enjoy the benefit of being members. The important roles of the Fishery Cooperatives are:

1. To coordinate fishing, handling, processing and marketing of fishery products. Most of the fishermen set off for their fishing ground late in the afternoon with the wind on their backs and return to land their catch with the wind from the sea. Only a few fish with motorized boats; some use outboard engines. Depending on their catch, or the distance to the landing place, the fishermen usually land their catch at different times. The landing place and the auction are always busy from early in the morning until noon. Fish merchants thus have to wait to collect enough fish to be packed in ice and sent to the consumer; this will certainly affect the freshness of the fish as ice is not always available. Not all landing places have adequate facilities for fish handling and many of them lack clean water and ice to wash and chill the catch. Brackishwater milkfish ponds are often far from roads and it may take hours before the milkfish can be iced.

With good coordination fish landings can be timed. The auction, as well as the subsequent handling and packing for transport, can then be carried out with minimum delay. All the necessary steps can be arranged by the Cooperatives, for example, coordinating the time of the landing, auction, market research and monitoring fish prices at the market.

2. To have all the fishermen as members. Where non-member fishermen sell their catch to the middlemen directly, the price and the payment are fixed by the middlemen. The auction should be supervised by the Cooperatives so the fishermen can get the highest price at that time. If the fishermen becomes a member of the Cooperative, the fish merchants cannot press him to sell his catch at a fixed price so the bargaining position of the fisherman will be improved.

Supervision of the auction by the Cooperatives will help the fishermen to receive more money. A percentage of this will be used to pay back their credit. Also, as Cooperative members, fishermen are taught to save for their own benefit.

Due to the economic weakness of the artisanal fishermen, they are exploited by the middlemen; borrowing money from these illegal small bankers is very easy with no collateral provided the fishermen promise to sell their catch to them. By proper management and supervision the Fishery Cooperatives can reduce the extent to which fishermen borrow money at high interest rates.

Cooperative members can obtain credit from the bank to buy fishing boats and gear more easily than an individual who must have collateral.

3. Through the Cooperatives, the knowledge and the skill of the fishermen can be improved, for example the improvement of fresh fish handling. Through liaison between the Cooperatives and the Research Institutes, the results of research activities can be applied, e.g., adapted modern processing, more advanced fishing methods and aquaculture techniques. Here extension activities will have a very important role.

To illustrate how a Fishery Cooperative could be of benefit to its members, the Fishery Cooperative at Muncar, Banyuwangi, East Java will be described briefly: The Cooperative has 600 member fishermen grouped into 50 units of 12, each has a purse seine net and catches oil sardine. The efforts of the Cooperative seemed to be successful and many other fishermen wanted to join the cooperative, but, due to limited quotas of nets allowed in that area, they could not be accepted. A percentage of the return from the auction is retained to repay the fishermen's bank loans on time and some fishermen finished their payments in half the time of 40 months allowed by the bank. The benefit of becoming a member of the Cooperative can be seen from the fact that the member fishermen have a daily income of more than Rp. 500 compared to Rp. 200 (Rp. 1 U.S.\$ 0.0024, April 1978) for the non-member fishermen. In its efforts to help the fish processors, the Cooperative gave credit for buying vans to transport fish to the market.

THE ROLE OF THE COMMERCIAL FISHING SECTOR

The main aim of the large fishing companies, especially joint ventures, is to catch exportable fish such as shrimp and tunas as well as to buy frog legs from local suppliers. There are several state-owned fishing companies with the obligation to serve domestic markets and to export as much as possible of their own catch.

One of the advantages of the commercial fishing companies is that they will buy the fishermen's excess catch so that the price of fish during the fishing season will not drop too low. By sending their carriers directly to the fishing ground along with their own fishing fleets, the companies can buy the fishermen's catch as soon as the fish is caught. Also the companies can supply good quality ice and other needed rations. By using refrigerated vehicles these companies can transport their catch to the market, domestic as well as abroad.

One of the state-owned fishing companies located in Central Java has built a modern landing place and shore facilities as well as purse seiners and refrigerated carriers. The company has its own distribution channel, equipped with insulated and refrigerated trucks, to transport the fish directly to the market. It is hoped that the company can help the marketing of fresh fish from outside Java to Jakarta and other big cities.

CONCLUSION

This paper tries to illustrate the present situation of the post-harvest technology in which marketing, improvement of present practices in handling of fresh fish as well as the introduction of new products have important roles in fishery development. The development has good prospects based on the following facts:

ample sources of fish are still available (more than 50 percent) and most of the catch will come from the artisanal fishery;

steps have been taken to improve fresh fish handling and the application of good hygienic and sanitary conditions to produce good quality fishery products. Quality control is applied to ensure standard quality of the end products;

the employment of skilled technical staff, in the fishing and processing industries, and of qualified managers at the Fishery Cooperatives, is increasing;

the Government has given emphasis to the Fishery Cooperatives which have important roles to improve the socio-economic conditions of the artisanal fishermen. Government supervision is still needed to ensure that the Fishery Cooperatives function properly, especially at the early stage;

commercial fishing companies are willing to cooperate with the artisanal fisheries. With their modern technology they can help the artisanal fisheries and in exchange the companies can buy the fishermen's catch;

new product development can be considered as one of the outlets to increase fish consumption, with minced fish as one of the main raw materials. It has to be started through middle and high income consumers. Frozen fish commodities may be a feasible new approach to increase fish consumption;

as a whole, the application of post-harvest technology, practised properly, is one of the most important factors to ensure effective utilization of fish and fishery products. Because fish is the most important animal protein resource, the exploitation of the fish resources must be managed properly.

PROCESSING OF TRADITIONAL FISH PRODUCTS IN MALAYSIA WITH SPECIAL REFERENCE TO THE STATE OF TRENGGANU

by

Wan Johari bin Wan Daud
MARDI, Kuala Trengganu, Malaysia

Abstract

The state of Trengganu has been chosen because more than half of the population are involved in some way or another in the fishing industry. The processing of marine products has been an occupation among fishermen in the state since fishing activities started. There has also been little development from the traditional methods of catching, handling, storing, processing and marketing of fish. This is reflected in the presence of the number of small boats and the distribution of many cottage-level fish processing industries.

The total fish caught in the state exceeds 50 000 tons per year with a value not less than M \$ 95 million^{1/}. The people in the state eat only one third of the total catch whereas two thirds, or 33 000 tons, are taken fresh or processed for export to the other states of Malaysia or other countries; this brings in more than M \$ 64 million to the state. Processed fish includes smoked tuna (katsuobushi), canned tuna, salted fish, squid, prawns, traditional products like keropok (fish/shrimp chips or crackers), belachan (shrimp paste), budu (fish sauce), and fish meal.

INTRODUCTION

Malaysia extends as a rough arc consisting of two portions bounded on one side, and separated, by the South China Sea. It comprises the former Federation of Malaya (now known as West Malaysia) and the former British colonies of North Borneo and Sarawak (now known as East Malaysia) with a total area of 128 553 mi².

The West Malaysian coastline extends to some 1 931 km while the East Malaysian is about 2 253 km in length. Fishing in West Malaysia is based mainly on pelagic species. Although the continental shelf extends 64-161 km from the shoreline, fishing activity is mainly confined to a narrow strip of water extending some 24 km seaward (Sidaway and Balasingam, 1971). An exception to this is the cage-trap fishery which operates some 64 km off shore and exploits some demersal species.

Of the marine fish landed in West Malaysia, more than 70 percent is utilized in the fresh state. Most of this fish is transported from points of landing to markets packed in ice. Small amounts are frozen for later thawing and sale as fresh fish. The rest is processed in various ways as shown in Table 1.

Boiled fish, belachan (shrimp paste), keropok ikan (fish cracker), keropok udang (prawn cracker), cincalok (pickled prawns) and budu (fish sauce) are traditional products. It can be seen that, of the total West Malaysian production of marine fish, between 6 and 10 percent were processed into these traditional products. These products are labour-intensive and are produced mainly for local consumption.

Trengganu, one of eleven states, is the most important on the east coast of West Malaysia in terms of fish landing and processing. Processing of traditional fish products is a daily activity of a considerable proportion of people in the coastal areas.

1/ M. \$ 1 = U.S. \$ 0.424 (April 1978)

Table 2 shows the products processed in Trengganu; the three main traditional products are keropok (fish crackers), belachan (shrimp paste) and budu (fish sauce)

Table 1

Utilization of fresh marine fish, 1976,
West Malaysia landings (in tons)^{a/}

Salted dried fish	6 068
Dried anchovies	5 737
Boiled fish	545
Manure fish	12 532
Fish meal	7 583
Dried prawn	1 198
Prawn dust	93
Belachan (shrimp paste)	946
Keropok ikan (fish cracker)	904
Keropok udang (prawn cracker)	18
Cincalok (pickled prawns)	1
Budu (fish sauce)	13
Smoked tuna	63
Salted squid	182
Peeled prawn	696
Jelly fish	11

a/ Adapted from Annual Fisheries Statistics, 1977

Table 2

Utilization of fresh marine fish, 1976,
Trengganu landings (in tons)^{a/}

Salted anchovies	1 217
Manure	1 448
Belachan (shrimp paste)	3
Keropok ikan (fish cracker)	219
Salted dried fish	2 009
Salted squid	115
Smoked tuna	63
Fish meal	28
Dried prawn	14
Budu (fish sauce)	0.8

a/ Adapted from Annual Fisheries Statistics, 1977

METHODS OF PROCESSING

Keropok (fish cracker)

This product is made from either fresh fish or prawns, and starch. Certain types of fish such as *Chirocentrus dorab* (ikan parang), *Clupea leiogaster* (ikan tamban beluru) and *Decapterus russellii* (ikan selayang) are preferred because of the quality of the flesh but other fish are also used. Tapioca starch or sago starch from the sago palm (*Matroxylon sagu*) are both used but sago starch is said to make the best product.

The process begins by cleaning and deboning the fish. The meat is then mixed with the required amount of starch; this varies from place to place but is usually a 1:1.5 fish to starch ratio. The mixture is then macerated or pounded in a mortar made of wood using two long wooden poles. A small quantity of water is added during the process. The maceration continues until the fish flesh and starch are intimately mixed to a smooth dough. This is important as it determines the degree of expansion in the final product. The dough is rolled by hand into long sausage-like rolls; this is important as it must produce a dense cohesive mass. The rolled dough is then cooked, usually in a round metal pan heated over an open fire. Cooking is continued until the rolls are firm and sufficiently solid and also until they float. After cooling, the rolls of dough are sliced with a knife; the cut being made obliquely to produce an oval slice. The slices are spread out to dry in the sun. They should be quite dry and brittle when finished. These are then collected and packed in polyethylene bags for storage and sale.

Some keropok makers sell their product at the roll stage, that is before cutting. This is common in villages where they want a quick market and will not have to cut and dry the product. However, this form of keropok will not last long because of its high moisture content.

The final operation consists of dropping the slices into deep hot fat which causes them to expand. This is a very popular product and is used as an appetizer or as a snack food. The better quality is a lightly coloured crisp with a mild fish flavour; it is not tough or chewy. A typical analysis of keropok made from *Clupea leiogaster* shows the following-

	(percent)
Moisture	15.8
Fat	0.8
Protein	29.6
Salt	3.7
Carbohydrate	48.4

Since this product is made mainly in the villages at cottage level, the quality is very variable. The ratio of fish to starch varies to suit the whim of the maker usually with an eye to the profit involved. The kind and quality of fish used also affects the quality of the product.

Belachan (shrimp paste)

Belachan is a fermented fish product made from very small shrimps by a process of salt-controlled anaerobic fermentation.

Small shrimps, *Acetes* spp. (udang baring, udang geragok), are mixed with fine salt and spread out on mats to dry in the sun for 5-8 h. A ratio of 7 parts salt to 100 parts of shrimp may be used, but this varies widely from one manufacturer to another.

The partially dried shrimp are then put through a mincer and packed tightly in wooden tube covered with burlap and set aside for 7 days to cure. In packing the tubs it is important that no air pockets are allowed to remain in the mixture as spoilage and discoloration would occur at these points.

At the end of 7 days the paste is dug out of the tubs, broken up and spread out to dry again for a further 5-8 h. This is followed by a second mincing and again the paste is packed into the tubs, covered and allowed to cure for about a month. The process of drying, mincing and repacking is then repeated. At this point it may be packed in blocks for sale. Some manufacturers repeat the curing, drying and mincing cycle several times. When properly cured, the product should be a deep purple colour, have a salty flavour and also taste strongly of shrimp.

There is a wide variation in colour and flavour. Artificial colour may be added to correct deficiencies in natural coloration. The yield from 45 kg of fresh shrimps is 22 kg of paste.

First quality products were found to have the following composition:

	(percent)
Moisture	27-40
Salt	13-18
Protein	30-40

It can be seen that even the first-grade product varies rather extensively in moisture and salt content. As the salt content is high, it is hygroscopic and, under conditions of high humidity, it is necessary to redry the product occasionally. Moisture should be maintained below 40 percent and if this is done the belachan will remain in good condition for two months or more.

Belachan is used as a condiment to flavour other less tasty foods. it may be baked or used directly.

Budu (fish sauce)

This is another traditional product which is made in small quantities as compared to the previous two. It is manufactured in only two of the states in West Malaysia, Kelantan and Trengganu, and consumed mainly by the people in these states. Fish sauce is known under different names in various countries in South East Asia, for example, nuoc mam in Democratic Kampuchea and Vietnam; nam pla in Thailand and Lao, patis in the Philippines; ketjap ikan in Indonesia and ngapi in Burma.

In Malaysia, it is prepared from small anchovies (*Stolephorus* spp.). The normal procedure begins with mixing uneviscerated fish with coarse salt in a ratio of 1:2 of salt to fish. The mixing takes place on mats under the sun and the mixture is transferred to fermentation tanks or silos which are generally constructed of concrete. After the tank has been filled to the top it is sealed off and will remain sealed for at least 6 months while fermentation takes place. The concrete silos may be either under a roof or simply exposed to the hot sun.

After fermenting for 6 months the mixture is filtered. The next stage is usually to heat up the filtrate with other ingredients such as tamarind and sugar (coconut palm sugar). The sugar is heated until shining hot in a pan and cooked. It is then cooled and kept in the large earthenware containers before being bottled. The finished placed over an open fire. The filtrate and the tamarind solution are then poured into the pan and cooked. It is then cooled and kept in the larger earthenware containers before being bottled. The finished product is dark in colour and has a distinct aroma and flavour. The flavour and aroma determine its quality.

An analysis of a typical budu sample gave the following results:

	(percent)
Moisture	69.1
Protein	10
Salt	18.5

Budu is marketed in bottles and eaten, in small amounts, with rice as an appetizer.

CONCLUSIONS

The traditional products described are the three commonly processed in Trengganu; they are not necessarily the three that are most commonly processed in Malaysia. From the account of the methods of processing, it is evident that they are produced at the village level.

As far as keropok is concerned part of the process can be mechanized. For example the deboning and the mixing can be carried out by deboning and mixing machines. This will not only make the work faster but also make the product more hygienic. The slicing can also be carried out by a mechanical slicer instead of by hand using a knife.

The fermentation period for fish sauce can be shortened if the micro-organisms and enzymes involved can be isolated, cultured and inoculated in the mixture. In this way the product can be made available within a short time. Halophilic bacteria are mainly responsible for the fermentation occurring in the preparation of fish sauces and pastes (Amano, 1961). They are found in the fish viscera and gills or are introduced with the salt or through handling. Approximately 70 percent of the bacterial isolates from a nine-month fish sauce were halophiles of *Bacillus* types (Saisithi *et al.*, 1966).

Other fish which have no commercial value can also be tried to produce fish sauce, but of course the final product must possess the flavour and aroma of budu. Research can also be geared toward the production of powdered dehydrated budu, this has been successfully done with nampla in Thailand.

In the case of belachan, further investigations should be carried out to develop cultures which could be used to make the product more uniform and also to speed up the process. The product should be packed with proper packaging materials to prevent dehydration.

In summary, it must be remembered that these traditional products provide a cheap source of protein to the people in this region. It is important that production should be continued and improved. It is an important source of employment in the fishing villages and of considerable economic value.

REFERENCES

- Amano, K., The influence of fermentation on the nutritive value of fish with special reference to fermented fish products of south-east Asia. *In* Fish in nutrition, edited by E. Heen and R. Kreuzer. London, Fishing News (Books) Ltd., pp. 180-200
1962
- Malaysia, Fisheries Division, Annual fisheries statistics. *Annu. Fish. Stat., Malaysia*, 1977
1977
- Saisithi, P. *et al.*, Microbiology and chemistry of fermented fish. *J. Food Sci.*, 31(1):105
1966
- Sidaway, E.P. and M. Balasingam, Fish processing industry in West Malaysia. Technical study. Paper presented at the Stable tropical fish products workshop held in Bangkok, Thailand, 8-12 October 1974. Sponsored by the International Development Research Center, Ottawa and the Department of Fisheries, Ministry of Agriculture and Cooperatives, Thailand
1974
- Trengganu, Department of Fisheries, Annual fisheries statistics. Kuala Trengganu, Jabatan Perikanan Trengganu
1977

IN SEARCH OF APPROPRIATE FISH-PROCESSING TECHNIQUES FOR INDONESIA

by

S. Ilyas
Research Institute of Fishery Technology
Jakarta, Indonesia

Abstract

Indonesian fishery activities have shown a remarkable increase since the end of 1967 when the country started adopting refrigeration techniques, especially freezing for export fishery commodities, i.e., crustaceans and molluscs. Meanwhile, an improved policy on planning and programming including research has been instituted and more attention has also been given to post-harvest technology research.

Accordingly, efforts to improve freezing methods and the handling of fresh fish in ice have been made and trials on the suitability of marine and inland fish species (prawn, tuna, lobster, milkfish, etc.) for icing and freezing have been carried out.

Improvements in the quality of traditionally processed fishery products (salted and dried, including salted jellyfish for export, boiled and salted, mechanically dried, smoked, etc.) have been made. Since the keeping quality of these products is relatively short (due to mould growth, slime formation, insect infestation and bacterial decomposition), the application of preservatives and chilling have been introduced.

Recently, special attention has been given to the utilization of trash-fish by ensiling. Preliminary data on feeding trials on animals and fish have shown encouraging results.

INTRODUCTION

A remarkable development has been achieved in the fishing industry within the last decade. Until 1967, development was relatively sluggish or static and traditionally oriented. Its contribution to the national economy was limited to local consumption and salted fish was imported from Singapore and Thailand.

By the end of 1967, refrigeration techniques were introduced, especially for freezing crustaceans and molluscs for export. Since then they have developed rapidly, followed by more input of technology into the fishing industry in handling, processing and marketing. Moreover, planning and management, education, training and extension as well as fishery research and development have progressed.

In 1976, frozen products accounted for around 76 percent in volume and 93 percent in value of foreign exchange earnings. Shrimp accounted for 58 percent in volume and 89 percent in value of exports. Thus the fishery sector has become very important. The contribution of fisheries to earnings in 1976 was U.S.\$ 131 million whereas in 1968 it was only U.S.\$ 2.5 million.

Unfortunately, there is an imbalance in the development progress of fisheries; export activities are growing tremendously while artisanal fisheries are left far behind with all their shortages and limitations.

Overall achievements should be evaluated for future planning, especially for laying out the next research programmes to support the industry. Fisheries development during the Third Five-Year Plan (1979-1983) will emphasize process of raw material into final products, as well as large-scale transmigration programmes from Java to the outer islands.

This paper will focus on the future research programme in connection with the period of development in the Third Five-Year Plan, taking into account experience during the last decade.

DEVELOPMENT IN COMMERCIAL PRACTICE

Potential and production

Although the total estimated potential of marine fisheries is about 6 million t, the present total catch is only 1.4 million t, of which 0.4 million t are derived from inland fisheries. The potential of freshwater aquaculture is also promising. There are 1 760 000 ha of freshwater swamps and flood areas, 27 000 ha of small reservoirs, 3 000 000 ha of irrigated rice fields and 6 000 000 ha brackish water swamps and tidal lands.

The increase of fish production in the last few years is relatively constant and there is a tendency toward species diversification, especially to those species which are in demand and fetch high prices; such as prawn, lobster, tuna, etc.

The development of fish utilization

The pattern of fish utilization has not changed greatly in the last few years, except for the increase of frozen fish from 0.5 percent in 1968 to 3.1 percent in 1976. Most of the frozen products are exported. It is expected that fresh fish for local consumption will increase. The provision of better handling and communication facilities has increased live-fish distribution while the amount of fish for curing has declined. The conversion of fish into fishmeal and other reduction processes has not been encouraged, although the demand is quite high. Also, there is still no commercial industry which uses minced fish for fish sausage, fish balls, etc., although the market for these products is known to exist.

Problems faced

The main problems faced by the Indonesian fishery industry are:

(a) Increasing fish consumption

During the last decade, fisheries production has increased in proportion to the growth rate of the population. Accordingly, the annual *per caput* fish consumption is still 10 kg, whereas the target has been put at 29.5 kg.

(b) To meet vitamin A and iodine requirements

A high percentage of pre-school children show symptoms of xerophthalmia as a result of vitamin A deficiency. Moreover, a considerable number of people are reported to be suffering from goitre.

(c) Considerable post-harvest losses

A considerable volume of raw material as well as processed products are being wasted, mainly due to lack of facilities, skill and knowledge of handling the fresh raw material. About 30 percent of prawns destined for export deteriorate and cannot be used for processing. Also, about 25-30 percent of salted fish are lost annually due to deterioration.

(d) Imbalance between Java and the outer islands

Sixty four percent of the total population of 135 million live in Java. The total number of fishermen in Java island is too high for the small fishery potential and, therefore, the production per unit effort is very low. Conversely, the potential in the outer islands is high.

The consumption of fish shows extraordinary differences. The annual *per caput* fish consumption of the people in Central Java is only about 5 kg whereas in some provinces in the outer islands the *per caput* fish consumption is up to 35 kg (more than the Government target).

These problems may be solved through transmigration programmes for fishermen and by stimulating marketing and distribution of fish to Java.

(c) Shrimp by-catch

Although there is an urgent need for fish to meet the protein and nutritional requirement of the people, about 150-200 thousand t per annum of shrimp by-catch in the East Indonesian waters are not utilized for human consumption. Most of it is reported to be thrown back into the sea. In fact, these abundant resources should have been used for direct consumption (especially the highly valued species) and used indirectly for animal and fish feed, through reduction or ensiling.

Characteristics of the Indonesian fishery

The Indonesian fishery is characterized by its tropical nature. There are great number of species but the fish catch is usually landed in small quantities in a number of dispersed landing places. As a result, handling and processing become more complex. The characteristics of these small-scale fisheries are lack of capital, skill and business acumen.

During the last decade a number of fishing enterprises with their own fleets and large shore-based processing plants with refrigeration facilities have been established. However, most of their raw material (about 90 percent) is still supplied by small-scale fishermen despite the fact that the products go to international markets.

Although artisanal fisheries are still important, the fishermen are in a weak marketing position. So far they have not been able to group themselves into bigger cooperative enterprises or to strengthen their competitive position against private traders and middlemen. Meanwhile, Government efforts to introduce cooperative societies have not been very successful. In this connection, the Indonesian Government has established several Government-owned enterprises with sufficient capital for marketing fish from the outer islands in Java. After they had operated for about two years, however, their achievements were not as good as they should have been.

Supervision of hygiene and sanitation in these home industries is especially difficult. It is hard to enforce quality control principles and to market the products due to differences of quality. It is, therefore, difficult to increase fish sales in order to stimulate increased fish production. There are also technical and economic difficulties in rationalizing their activities which discourage fish production.

RESEARCH SUPPORTING THE INDUSTRY

Handling

Indonesian fisheries are characterized by small villages scattered along the coast. This makes the provision of facilities such as jetties, auction halls, potable water supplies, ice, etc., more difficult. The economic fish species are collected from small villages and subsequently transported and marketed in big cities; some are locally processed. Ultimately, the end products will be of poor quality due to poor handling.

Since handling facilities are so variable, and in some areas lacking, considerable quantities of fish are un-iced during handling and auctioning. Where icing is practised, this is usually carried out several hours after catching. Therefore, fresh fish are of variable quality in the market. Not much work has been done to study the relationship between delay of icing and deterioration level or keeping quality. Several observations have been made on the deterioration of brackish water prawn, milkfish, carp, *Puntius*, and frogs held at ambient temperature. It was shown that at ambient temperature in Jakarta (25-33°C) these products undergo deterioration within a few hours (Table 1). Most of the catch had undergone deterioration and the bacterial counts were high, due mostly to contamination during handling. It has been reported that about 20 percent of the shrimp trawled off Cilacap

(south coast of Central Java) are unsuitable for freezing for export. Meanwhile, Spanish mackerel which are kept in ice soon after catching will stay in rigor for up to 36 hours.

Table 1

Shelf-life at ambient temperature

Species	Storage Temperature (°C)	Shelf-life (h)
Shrimp ^{a/}	25.0–28.5	7
	28.5–32.2	6
Milkfish	25.0–28.5	14
	28.5–32.2	9
Common carp	30.0–33.0	10
Silver carp	30.0–33.0	12
Froglegs	26.8–32.0	5

a/ Pond shrimp

Icing

Icing experiments on fish soon after capture can be more easily carried out using freshwater rather than marine fishes. The shelf-life of several fresh water fish during ice storage is shown in Table 2a and b.

Table 2

Shelf-life at chill-temperature storage

a) Inland fish

Species	Medium	Temperature of products (°C)	Shelf-life (days)
Milkfish	Freshwater ice	0.0	14
	Brine 2% plus ice	–1 to –2	14
	Brine 2% plus ice	–1 to –2	15
Milkfish (1 h transport in ice)	Freshwater ice	1.0	16
(30 h transport in ice)	Freshwater ice	0.9	11
Shrimp ^{a/} (30 h transport in ice)	Freshwater ice	2.0–3.0	11
Froglegs	Crushed ice	0.5–2.5	4
	Water and ice	1.0–3.0	4
Silver carp	Crushed ice	3.0–4.0	18

a/ Pond shrimp

b) Marine fish

Species	Delay of icing (h)	Type	Temperature of products (°C)	Shelf-life (days)
				24
Yellowfin tuna	5	whole	1.0–2.0	18
Skipjack	7	whole	0.8	15
Small tuna	8	whole	1.0	5
Horse mackerel	5	whole	0.5	5
Mackerel	8.5	whole	0.4	12
	3.0	whole	0.5	11
<i>Decapterus</i> sp	—	whole	0.5	18 ^{a/}
Red snapper	—	whole	1.0	19
		dressed	0.7	up to 3
Lobster	—	whole	0.6	5
		headless	0.4	4
		whole cooked	1.0	7 ^{b/}
Shrimp	—	whole	1.0–2.0	7
Scallop (<i>Anadara</i> sp.)	—	whole/shell-on	1.5	8
		raw meat	0.5	7
		cooked meat	0.5	

a/ Iced at sea

b/ Raw alive

Table 3

Storage life of some important cured products

Species	Processing	Storage temperature (°C)	Shelf-life
Shrimp	Boiled in brine, dried, shell off	5.5 28–33	up to 6 months 3 months
	Boiled in fresh-water, dried, shell off	5.5 28–33	6 months 2.5
	Shell off, boiled in brine, dried	5.5 28–33	up to 6 months 3 months
Mackerel	Dry salted (30%) for 65 h dried – NaCl 15%	6.0 27	up to 100 days less than 78 days
	Dry salted (30%) + acetic acid soln. (1%) for 65 h, dried – NaCl 15%	6.0 27	up to 100 days 95 days
	Dry salted (30%) for 6 h, dried, bamboo basket packed – NaCl 14%	3.0 25–30	180 days 120 days

<i>Decapterus</i> sp.	Dry salted (30%) for 6 h, dried, plastic pouch packed – NaCl 14%	3.0 25–30	up to 180 days 150 days
	Dry salted (25%) for 68 h, mechanical drying ($t = 39.5 - 42.5^{\circ}\text{C}$, RH 47–62.5%, air velocity 103 m/min)	2–5 26–31.5	up to 310 days 90 days
Mackerel	Dry salted (25%) for 68 h, sun- dried for 18 h	2–5 26–31.5	up to 310 days up to 90 days
	Dressed, brined (5%) for 10 min, boiled in brine (15%) for 1 h, bamboo basket packed	2–5 25–30	up to 90 days 5 days
Jellyfish	Salted (25, 30 and 30%) mixed with alum (2, 6 and 10%)	6.0 27.0	up to 60 days less than 60 days
	Salted (20, 30, 40%) mixed with alum (1, 3 and 5%)	6.0 27	up to 140 days 65–100 days
	Salted (30 and 35%) mixed with alum (1.5, 2.0, 2.5 and 3.0%)	6.0 27.0	up to 225 days 88–102 days
Milkfish	Dry salted (30%) for 3 h, hot and cold smoking	0 29.5	up to 78 days 22 days
	Ditto, with 1% sorbic acid spray	0 29.5	up to 78 days 22 days
	Ditto, with 2% sorbic acid	26.6–31	moulding after 8 days
Silver carp	Dry salted (30%) for 6 h, sun- dried, bamboo basket packed	2–5 25–30	up to 180 days 90 days
	Dry salted (30%) for 6 h, sun- dried, plastic packed	2–5 25–30	up to 180 days 90 days

It appeared that milkfish, kept in 2–3 percent chilled brine had a slightly longer shelf-life compared to ice storage only, but there was an increase of salt content in the fish muscle. In this connection, the use of salt-water ice is not recommended, since there is no significant effect on extension of shelf-life over freshwater ice; in addition, the cost of the plant is high.

Milkfish which has been transported in ice for 1 hour had a longer shelf-life (16 days) than fish transported in ice for 30 hours (11 days).

Froglegs stored in crushed ice or in a mixture of ice and water had an equal shelf-life, although there was a difference in appearance.

Studies on the relationship between delay of icing (in hours) and the shelf-life of marine fish during ice storage have not been made. However, research and observations on icing of fish landing, both for un-iced as well as incompletely iced fish, have been carried out.

Storage of processed products

With a view to improving the quality of traditional products, several curing experiments have been carried out (salting, drying, boiling, smoking, etc.). Most of the products have a relatively short shelf-life, especially under ambient storage conditions. In this context, some products have been stored under chill temperature; the results are given in Table 3.

Freezing

Freezing is still restricted to export commodities. Information on species commonly used for freezing in connection with delay of icing and storage life is given in Table 4.

Table 4

Storage life of some important species during frozen storage

Species	Preparation	Milk fish Storage temperature (°C) 17.8	Shelf-life up to 12 weeks
Lobster (alive when processed)	Head off, iced 13 h, frozen	-20	6 months
	Cooked whole, iced 13 h, frozen	-20	up to 4 months
	Iced whole 13 h, cooked whole, frozen	-20	4 months
	Head off, iced 12 h, frozen	-20	163 days
	Head off, iced 24 h, frozen	-20	159 days
	Head off, iced 36 h, frozen	-20	153 days
	Head off, iced 48 h, frozen	-20	144 days
Crabs (alive when processed)	Cooked meat, water medium	-23	up to 4 months
	Cooked meat, without medium	-23	less than 4 months
Shrimp	Shell off, cooked, frozen	-23	less than 6 months
	Boiled, shell off, boiled, frozen	-23	7 months
Milkfish	Iced 3 h, frozen (bait)		-17.8 up to 12 weeks

Although skipjack and other tunas are commercially frozen for export, there's still no integrated research on the degree of freshness related to their shelf-life during frozen storage.

Canning

A study on the possibility of using papaya sauce, or a blend of papaya with tomato sauce, for the canning of sardine is being carried out. It is expected that papaya will become an economic substitute for tomato sauce as the supply of tomato is inadequate.

Processing of salted jellyfish

Due to the lack of information, experiments on processing of salted jellyfish with the incorporation of salt and alum have been carried out. The range of salt concentration used was 0-40 percent combined with 0-10 percent alum. It was concluded that the optimum salt concentration is 30-35 percent combined with 1.5-2.0 percent alum (by weight of raw jellyfish).

The experiments reveal that there is a downward trend in quality regarding texture, crispness, odour and flavour, as well as thickness and yield, with increase of alum added during processing.

The amounts of salt and alum used during processing of jellyfish should be related to factors such as species of jellyfish (cendol, kelapa, etc.), the degree of freshness of the raw material, the purity of additives (salt, alum,

water, etc.) added, and the possibility of the presence of borax in material used. Borax is considered as a contaminant.

Utilization of shark liver oil

The level of xerophthalmia in Indonesia is high. Large numbers of shark are caught along with other commercial species. They have high vitamin A content in the liver (10 000–11 000 IU); experiments have been done to make use of them.

Experiments on the methods of preservation of shark liver and extraction of its oil have been carried out in connection with its utilization as a source of vitamin A. Three methods of preservation of raw liver, i.e., icing, salting and freezing as well as two methods of extraction, namely alkali digestion and steaming, have been carried out.

The results showed that freezing appears to be the best method of preservation, while chilling was better than salting. Alkali redigestion gives better yield of the oil and vitamin A than steaming.

Organoleptic tests on shark liver during storage and the effects of prolonged storage on the yield of the oil and its quality have also been carried out. The longer the storage time, the lower are the yields of oil and vitamin A.

The present problem is to find out a simple and practicable method of extraction for use by the small-scale fishermen. The practice of making shark liver pindang (salted boiled), especially in West Java, might be adopted in other regions, provided that this method can retain the high vitamin A content of the processed shark liver. Research continues in this field.

Fish silage

Laboratory experiments on the utilization of shrimp by-catch for fish silage are being carried out. The silage is being used for feeding trials on pigs, ducks, chicken and fish and preliminary results are encouraging.

DISCUSSION

Practical problems which may be relevant in connection with future research programmes are discussed below. It is considered unnecessary to investigate the application of established principles and procedures. Poor handling and processing practices should be tackled through extension as a government service rather than by research.

Fish handling

In commercial practice, about 20 percent of the highly valued raw material (prawns, etc.) shows advanced deterioration on arrival at the processing plants; this leads to a considerable loss in terms of foreign exchange.

Handling of other species meant for local consumption is worse and the quantity of fish unsuitable for human consumption or further processing reduces the income of the fishermen and discourages people from purchasing and consuming fish. The technical problems include the variable catch composition, lack of insulation in the fish hold, the availability and high price of ice, the negligence of fish handlers and poor handling during auctioning. Unmotorized boats which make trips of about 15 hours, usually do not carry ice or insulated boxes even for high-valued species.

Freshwater species caught in brackish waters are handled as poorly as those on board fishing vessels with the exception of freshwater cultured species which are usually handled and distributed alive. Improved methods of handling freshwater fishes are being developed in many regions of the country.

The deterioration of fresh milkfish during handling and transportation to the market should be prevented by establishment of a better communication network, widening the ponds' embankments in isolated areas, provision of collection points with clean water, iced and containers for fish storage and transportation.

The handling problems of froglegs as one of the raw materials for export is still unsolved. It will be necessary to establish collecting points in some rice field areas, with provision of hygienic handling facilities, particularly to prevent *Salmonella* contamination.

Marketing of fresh fish

Most of the fish except those for export, which are sold fresh are not eviscerated, filleted, etc., and are not packed in ice in suitable packaging material. The practices of beheading, gutting, skinning, etc., are carried out in a most unhygienic way in dirty places around the auction halls and fresh fish market. The Government may have to provide improved facilities as a public service.

Freezing

Broadly speaking, there are no problems in commercial freezing. Freezing activities are limited to export commodities. The quality and shelf-life of the frozen product are still adversely affected by the variability in raw material, some of which is un-iced or poorly iced fish. There is need for research on the effect of delayed icing and duration of iced storage before freezing related to keeping quality in frozen storage.

Canning

Sardine and skipjack are among the important species available for canning. Abundant supplies of sardine are available in the Bali Straits and skipjack in the East Indonesian waters. Canned fish imports continue to increase. During 1976, the export value of canned fish reached U.S.\$ 10 million, of which U.S.\$ 8 million was canned mackerel. The quality of locally produced canned fish around Bali Straits is unable to compete with the quality and price of import products. This is mainly due to the high price of tinplate and the poor condition of the present processing facilities.

Curing

The present curing practices (especially salting followed by drying under the sun, salting and boiling, light and heavy smoking and fermentation) usually result in products of relatively short shelf-life. Few studies directed toward improvement of techniques and quality of traditional products have been made since priority has been given only to quality improvement of export commodities (cooked-dried prawns, salted jellyfish, etc.). Laboratory experiments have resulted in high quality end products. Although salted boiled products (pindang) are very popular, suitable types of containers for cooking/packaging and distribution have to be found.

Fishmeal and fish silage

Up to the present, the production of fishmeal is insufficient to support the development of animal husbandry and fish culture. This can be observed from the increasing imports of fishmeal. This may be because it is difficult to collect enough by-catch, as the raw material, to supply even a small-scale fishmeal factory (30-50 t/day). In some fishing areas, the traditional reduction practices of cooking, pressing, drying and grinding are practised but the quality of the end product is not consistent.

As an alternative, the by-catch could be ensiled. This technology could be developed for rural areas providing that feeding trials for pigs, poultry and fish are successful.

Utilization of shrimp by-catch

Although by decree of the Ministry of Agriculture it is compulsory to land the shrimp by-catch from East Indonesian waters, about 150 000 t of shrimp by-catch are thrown back to the sea because of technical problems of collection and storage, especially in small trawlers. There is a need to identify suitable species for fresh marketing, mincing and salting with the remainder used for ensiling. Although shrimp trawlers have operated in this area for over seven years, no enterprise considers it profitable to establish a fishmeal plant. It is felt necessary to establish a fishmeal plant. It is felt necessary to establish a post-harvest technology laboratory branch in Ambon to work on these problems encountered in the vast East Indonesian waters.

Storage

Ambient temperature storage caused considerable loss of processed fishery products due to rapid deterioration, moulds, insect infestation and rodents. Better packaging (using plastic film pouches) improves the appearance of the products and extends the shelf-life, but does not solve all the problems. Chilled storage of the traditionally processed products could prolong their shelf-life considerably, and stabilize the stocks during the off-season. To encourage fish consumption, especially by low-income groups, the Government may subsidize these products.

Distribution

In an archipelago like Indonesia, the main production and consumption areas are far apart and transportation between islands is a problem. Shipment of fishery products by sea always has lower priority over other cargo because fish tend to produce an unpleasant odour and tainting. As a consequence, the Government may have to provide special facilities for the transportation of these most perishable products.

There is a need to increase the amount of refrigerated transport. The alternatives to mechanical refrigeration, e.g., the utilization of industrial by-products such as liquid and solid carbon dioxide, should be considered also. At present, the production capacity of carbon dioxide is 150 t/day, whereas the demand is for only 30 t/day, mainly for ice-cream distribution. The problem is to find a simple method for its incorporation with insulated boxes, vehicles, railway cars and fish holds.

Improvement of distribution facilities is one of the most important factors for increasing fish consumption in Indonesia.

Sanitation

During the last decade, fisheries development has concentrated on catching facilities (especially motorized fishing vessels) and improved landing facilities, auction halls and marketing. However, the sanitary conditions remain poor and to date no attention has been given to their improvement.

Quality control

Although recently introduced, the Research Institute of Fishery Technology has been able to advise on quality control measures which have been taken up by the fishing industry. Advice on quality control has been given by the Directorate General of Fisheries since 1975. The Research Institute of Fishery Technology also assists Government with the inspection of producing centres, preparation and finalization of analytical methods and the procedures to be followed. In addition, it assists with training quality control officers, both in the Government and in the private sectors, and the preparation of quality standards. National standards for frozen prawn and froglegs have been legalized by the Department of Commerce, while standards for salted jellyfish, salted fish and salted-dried prawn are being prepared.

Although progress has been made in controlling the quality of export commodities, it is difficult to enforce these principles for commodities meant for local consumption, probably due to the characteristics of small-scale (home industry) fisheries. The Government will have to give special priority to these commodities if the programme of increasing fish protein consumption is to be successful.

Institutional framework

To solve the above-mentioned problems interdepartmental team-work and an interdisciplinary approach are required.

SUMMARY

Until 1967, the Indonesian fisheries were small-scale, static, subsistence activities. However, in the last decade, new industrial fishery enterprises with modern facilities and sufficient provision of capital have emerged. They are having an effect on artisanal fisheries which tend to adopt new technology more slowly. Ultimately, there are two different patterns of fishery development in the country. On one hand, there is an industrial fishery sector which will eventually change the scope of the second sector, the artisanal fishery. Another phenomenon is the urgent need for fish protein by the people, especially in Java. In this connection, due to the unbalanced situation of fishery potential against the number of fishermen and total population as well, a considerable number of farmers and fishermen have to be transmigrated to outer islands.

It is necessary to introduce appropriate technology in the rural areas. This technology should not be capital-intensive; it should be suitable to the local educational ability and able to absorb considerable manpower. This type of technology will be developed for inclusion in the Third Five-Year Plan (1979-1983). It will aim to utilize the available resources efficiently so that the raw material can be processed and preserved into high-quality end products. This is true especially in the new resettlement areas.

The adoption of complex (composite) technology will continue; it is still necessary to stimulate icing, chilling, freezing and canning techniques, especially for the main export commodities. In the East Indonesian waters, a reduction industry (fishmeal plant) might have to be established to support the development of animal husbandry and fish culture industries.

It is important that the programme should emphasize improvement of traditional methods by the use of appropriate technology throughout the rural areas, in order to improve the income of small-scale fishermen as well as levelling the prosperity.

In addition to the improvement of procedures and facilities for handling, processing, packaging storage and distribution, improvement of the institutional framework is necessary. In this way appropriate technology can be economically and technically tailored to small-scale fishermen.

STATUS AND PROSPECTS OF THE FISH PROCESSING INDUSTRY IN THE PHILIPPINES

by

Gloria Guevara
Bureau of Fisheries and Aquatic Resources
Intramuros, Manila, Philippines

Abstract

The Philippine Government, through the Bureau of Fisheries and Aquatic Resources and other agencies, launched the Expanded Fish Production Programme in 1970 and this has led to an increase in fish production. The rapidly expanding fishing industry is now supplying annually around 1.6 million t of fish which form the basis of the fish processing industry in the Philippines. About one third of the annual total catch is processed as salted, dried, smoked, fermented, frozen and canned products and as fish meal.

Drying and smoking and other fish processing methods, as practised in most fishing areas, are the traditional methods that have existed for years. There is a lack of modern processing technology and of trained manpower in fish processing.

However, steps are being taken by the Government to counteract these problems. Efforts have been concentrated on the improvement of the traditional methods of fish processing on the development of export products and import substitutes. Attention is also given to the elimination of wastage in processing, marketing and distribution.

INTRODUCTION

The Republic of the Philippines has more than 7 000 islands with an irregular coastline of 18 000 km. In addition, there are about 9 000 km² of fresh water and 5 000 km² of brackish water and swamp lands. The Philippines has a bountiful supply of fish and the fisheries are of considerable importance in the national economy, both as an industry and as a source of food. Some 2 000 species of fish, molluscs, crustaceans, echinoderms, coelenterates, corals, turtles, seaweeds and other aquatic fauna and flora occur in the Philippines.

Fish has always been an important item in the Philippine diet. It constitutes more than 50 percent of the animal protein intake of the average Filipino. However, fish production has not met the needs of the fast growing population despite the extensive fishery resources. The average *per caput* consumption has been estimated at between 30 and 40 kg, which is relatively high by world standards.

There is an awareness of the necessity to exploit the country's fisheries. The Philippine Government is making efforts toward increased fish production through the Bureau of Fisheries and Aquatic Resources, which is implementing a fisheries development programme including the improvement and development of the fish processing industry.

HISTORICAL BACKGROUND

Traditionally the inhabitants along the coastal areas practice methods of fish processing such as salting, drying, pickling, broiling and smoking. These methods are employed during peak seasons and the products are intended for home consumption. Marketing surpluses are bartered.

Small species of fish, such as anchovy, sardine, goby fry and mackerel, are the raw materials used for salting. Salting of small fish is usually carried out in wooden bancas or concrete tanks, which may either be

packed as fish pastes or immediately sold after salting. Smaller species, such as anchovy, are dried without salting while the larger fish, such as groupers and roundscads, are salted before sun-drying. Some are skewered on bamboo sticks and sun-dried. Smoked fish in the Philippines is of Chinese origin; this product differs from smoked fish in temperate countries in that the fish are boiled in brine prior to smoking.

Canning was introduced as early as the 1930s but did not flourish. The slow development of the canning industry can be traced to the lack of technical know-how in the methods of canning. In recent years, the canning industry has remained undeveloped and neglected and millions of pesos are being spent by the Government for the importation of canned products.

Some 20 years ago, fish landings were 1-2 km from the shore. The catch was ferried ashore by amphibious vehicles or by dugouts with motors and outriggers. Ice was bought from private plant operators and was mechanically crushed before loaded into trawlers or fish carriers prior to departure to the fishing grounds. Immediately after capture the fish were packed in 'bañeras', circular galvanized iron containers, in ice, with approximately 3 parts ice to 7 parts fish.

THE PRESENT FISHERY

The pressures of the growing population have placed food production at the top of government priorities. With the campaign to increase food production an intensified national drive to develop the country's fishery resources has been launched. This expanded fish production programme aims at attaining self-sufficiency in fish supplies. The programme also aims at promoting import substitutes and developing an expanded export of fishery products.

For the purposes of fish production, the resources are subdivided as follows:

Marine

- (1) Commercial fisheries: covered by fishing vessels 3 GT or larger;
- (2) Municipal fisheries: covered by fishing bancas less than 3 GT, using relatively simple gears, operating mostly in shallow coastal areas and primarily used for subsistence fishing.

Inland

- (1) Brackish water fisheries
 - (a) brackish water fish ponds: for milkfish (*Chanos chanos*) and prawn culture;
 - (b) estuaries: for culture of oysters, mussels, etc.
- (2) Freshwater fisheries
 - (a) freshwater fish ponds: for culture of carps, tilapia and others;
 - (b) communal waters: lakes, reservoirs, rivers which, like the municipal fisheries in marine waters, are generally utilized by subsistence fishermen.

Contribution to the economy

As a whole, the fisheries sector contributed 4.25 percent to the GNP in 1974; the fish supply situation is shown in Table 1. The fishing industry directly employed an estimated total of 795 000 fishermen in 1974. Indirectly, the industry provides employment to those engaged in fish marketing and distribution, fish processing, operation of ice plants and cold stores, and to those in allied industries such as net-making, boatbuilding, etc. While normal production reached a 4.6 percent growth rate during the period 1968-72, there has been a signifi-

1/ P.Ps. 1 = U.S.\$ 0.136 (April 1978)

cant increase to 5.2 percent in 1968-74. Total production in 1968 was 937 700 t, valued at P.Ps. 1 362 million^{1/}, while the corresponding figures for 1974 were 1 268 400 t and P.Ps. 5 570 million. Production projections, based on a 4.6 percent growth rate, are shown in Table 2 (production targets are given in Tables 3 and 4 and Figure 1).

Exports steadily increased from 1 980 t (P.Ps. 4.9 million) in 1968 to 22 867 t (P.Ps. 130 million) in 1974, representing an elevenfold increase or 50 percent growth rate in volume. The major exports in 1974 were frozen fish and shrimp; Japan and the U.S.A. were the main markets. Imports were reduced over the period 1968-74, from 88 291 t (P.Ps. 99 million) to 56 461 t (P.Ps. 233 million). The bulk of the country's imports in 1974 were canned fish (83 percent) and fish meal (16 percent) supplied mostly by Japan and Peru, respectively.

Table 1

Fish supply situation (t), 1974

	Domestic production	Foreign trade		Available supply
		Export	Import	
Fresh fish	1 241 899	12 499	2	1 229 452
Canned fish	—	—	47 108	47 108 ^{a/}
Crustaceans, molluscs	26 469	1 809	—	24 660
Dried, salted, smoked fish	N.A.	343	4	(339) ^{b/}
Total	1 268 368	14 601	47 114	1 300 881 ^{c/}

a/ Equivalent to 67 297 t fresh fish

b/ Equivalent to 565 t fresh fish

c/ If canned, dried, salted and smoked fish are converted to fresh fish equivalent, total available supply is 1 320 844 t

Note: The net import is 32 513 t; this is equivalent to 52 476 t fresh fish

Table 2

Production projections at 4.6 percent growth rate

Year	t
1974	1 268 400
1975	1 326 700
1976	1 387 800
1977	1 451 600
1978	1 518 400
1979	1 588 200
1980	1 661 300
1981	1 737 700

Table 3

Effective demand and production target (t), 1977-1981

Year	Effective demand (4.2%)	Target production (5.5%)	Annual incremental production
1977	1 495 000	1 489 400	77 600
1978	1 557 700	1 571 300	81 600
1979	1 623 200	1 657 700	86 400
1980	1 691 400	1 748 900	91 200
1981	1 762 400	1 845 100	96 200

Table 4

Production targets by fishery sector (t), 1977-81

Sector	1977	1978	1979	1980	1981	Average growth rate (%)
Inland fisheries	157 400	173 800	191 100	209 300	228 500	10.8
Municipal fisheries	779 600	814 800	851 900	891 100	932 500	4.5
Commercial fisheries	552 400	582 700	614 700	648 500	684 100	5.5
Total	1 489 400	1 571 300	1 657 700	1 748 900	1 845 100	5.5

THE FISH PROCESSING INDUSTRY

The bulk of the country's total catch is consumed in the fresh state. Only about 40 percent of the total annual catch, which is approximately 1.3 million t, is processed in the Philippines.

Domestic production of salted, dried, smoked and fermented products is sufficient in larger national markets. These items are produced through a system of small-scale units as home industries.

Drying

At present, household and commercial drying using solar radiation is still the most common method of preserving fish in the Philippines. Drying is practised in every fishing village and by this method it is possible to utilize fish surpluses.

Drying as a method of fish preservation is still an important industry. It provides a storable product, creates employment and, with its great flexibility, handles a large volume of fish from small widespread units.

The method used is to salt the fish by immersing in brine before sun-drying on bamboo trays for 1-3 days depending on the size of the fish used and the prevailing weather. Since drying in the open is hampered by weather during the rainy season, some processing plants use artificial driers. The product has a moisture content of 30-40 percent of the total weight.

The dried, small fish are usually packed in boxes of 25 kg; larger fish are wrapped in matting, in various sizes, for transport and distribution. For retail distribution, they are packed in plastic bags. The dried products can be stored for 2-6 months and they are distributed to shops and markets throughout the country. Dried fish is

a staple product in the Filipino diet; it is accepted and consumed by all income groups and in all localities of the country. Dried fish which are not sold for reasons of poor quality go to the fish meal factories and are converted into feed.

Salting-fermenting

The practice of fish salting has been slow to improve through the years. The fishermen still cling to old methods. Sardines or other small fish are brine-salted, drained overnight and packed in loose salt. The finished products are packed in wooden boxes or boxes lined with mats or plastic film.

Salting with fermentation is also a common way of preserving fish in this country. The products obtained are fish paste (bagoong) and fish sauce (patis). The manufacture of fish paste and sauce is a traditional industry and it plays an important role in utilizing fish surpluses, especially the trash fish. Some of the species used for fish sauce and fish paste manufacture are *Stolephorus* sp., *Sardinella* sp., *Anodontostoma* sp., *Decapterus macrosoma* and a mixture of small fishes.

Fish and salt are mixed, fed into a fermentation tank and allowed to ferment for about one year for patis and 6 months for bagoong. Patis is drawn off as a clear liquid, containing fish protein, salt, etc. It has a particular, agreeable taste and is widely used in the Philippines for salting and seasoning many types of food. The bagoong is used in a similar way.

Production of fish sauce takes place partly at the cottage level but also in well-equipped, medium to large size factories. There are still many small operators producing less than one tonne of fish paste per year and many do not have bottling facilities. They sell either to vendors in public markets or to entrepreneurs who bottle and distribute their product under an established brand name. The fermented products require a long period for production and they can be stowed for long periods.

Smoking

Smoking of fish is carried out in villages, towns, cities or in places where daily transport, of the product, to central markets is possible. The major species used are sardines, milkfish, roundscad, mullet and mackerel. Cleaning in fresh water is followed by removal of gills and internal organs. The fish are then washed thoroughly and are allowed to drain. For cooking and brining (all species except milkfish) a large tub is filled with water, and salt is added to give a concentrated solution. This is then heated and when the boiling point is reached the fish are cooked for a period of time, depending upon the species and the size of the fish. For milkfish, they are soaked in a brine solution and then cooked. After brine-cooking, the baskets are drained and cooled. Before smoking, some processors sundry the fish or allow them to stand overnight (when cooked in the afternoon) prior to smoking the following day. The mode of smoking depends primarily upon the type of smokehouse. Hot smoking is commonly practised; sawdust or shavings of hardwood are used as fuel. During peak seasons the fish are cooked in bulk, stored in cold storage and smoked during lean months. The products are sold directly in the trays in which they were smoked or are repacked in boxes. The used trays are shipped back to the processors.

Freezing

Fresh fish are generally marketed whole or in the round and occasionally the larger ones are sold as steaks or chunks. At present, most of the supermarkets in the Greater Manila area sell frozen fish (whole or gutted); fillets, packed in plastic bags are also sold. Tuna, milkfish and shrimp constitute the bulk of the frozen marine products for export but frozen scallops and cuttlefish are also exported. The Philippine Fishery Exporters have acquired the necessary experience in preparing the product. They have also learned to trade and arrange shipments. In 1976 the country exported a total of 17 382 t of fish and fish products, valued at U.S.\$ 36 million; of this amount, 7 970 t were frozen products, valued at U.S.\$ 17 million.

The domestic market for frozen marine products is limited because the Filipino consumer has a prejudice against this type of product. The freezing industry in the Philippines is quite small. Shrimps are frozen at the rate

of 1-2 t/day, milkfish 1-10 t/day and lobster no greater than 0.5 t/day. Processing is carried out without sophisticated equipment and technology. Contact plate and blast freezers are the most common types used and a typical processor would have a daily freezing capacity of 4-5 t and a storage capacity of 80 t. There is one government-owned freezing plant in Greater Manila, the Food Terminal Inc., which operates a commercial blast freezer with a capacity of 80 t and a freezer storage capacity of 300 t. The plant is used for freezing marine products for export.

Canning

There are a few canneries in operation and their output is too small to supply the domestic market. The cost of production is great and, as a result, the products are too expensive for most consumers. Canning as an industry is still limited to small quantities of tuna and tuna-like species, mackerel, sardine and occasionally milkfish. The canning industry in the Philippines has not received much attention and has therefore not developed, and it has been necessary to import large quantities of canned products. Given proper incentives, the local canning industry could be fully developed.

Mincing

The manufacture of fish sausage and fish cakes was introduced as early as 1957 by a Filipino fishery technologist who had been trained in Japan. The product has gained acceptance but is not yet produced on a commercial scale. Fish cakes and fish sausage are prepared from shark, tuna, croaker and lizard fish. The success of the fish sausage industry in this country will depend on the availability of raw materials and the cost of production.

Fish meal

In the Philippines, fish meal gained popularity in the early 1950s. It was used as an ingredient in the formulation of feeds for poultry and livestock. The Government now encourages its production on a commercial scale. There has been a considerable increase in fish meal consumption, which has boosted the local industry but local production is still too low to meet the increasing demand.

The raw materials usually consist of assorted fish which are either whole or scrap. The most commonly used are roundscad, sardine, slipmouth, big-eyed scad, anchovy, tuna and fish scraps and waste from the canning factories. The process of fish meal manufacture consists of cooking, pressing, drying and milling fresh fish until a dry meal is obtained. The method used by local producers is a crude, dry rendering method. Raw fish are cooked, dried under the sun, pulverized and packaged in sacks.

PROBLEMS OF THE FISH PROCESSING INDUSTRY

The fish processing industry is not without its problems. Among them are the following.

- (1) Shortage of supply and the high cost of raw materials at landings. This is particularly true for canning since acceptable grades of fish are not available in a sufficiently regular supply to justify full capacity operation.
- (2) Improper fish handling, icing and sanitation practices.
- (3) Need for the improvement in the processing of traditional products and for the development of new products for export and for import substitution. There is a need for more quality control measures to be practised in most processing plants.

- (4) Inadequate infrastructure, such as harbours and other facilities. There are not enough cold stores for frozen fish from which the processor can draw his supply of fish at reasonable prices throughout the year.
- (5) In canning, the high cost of tin plate is the main problem. As a result there is stiff competition from imported canned products, particularly sardine and mackerel.

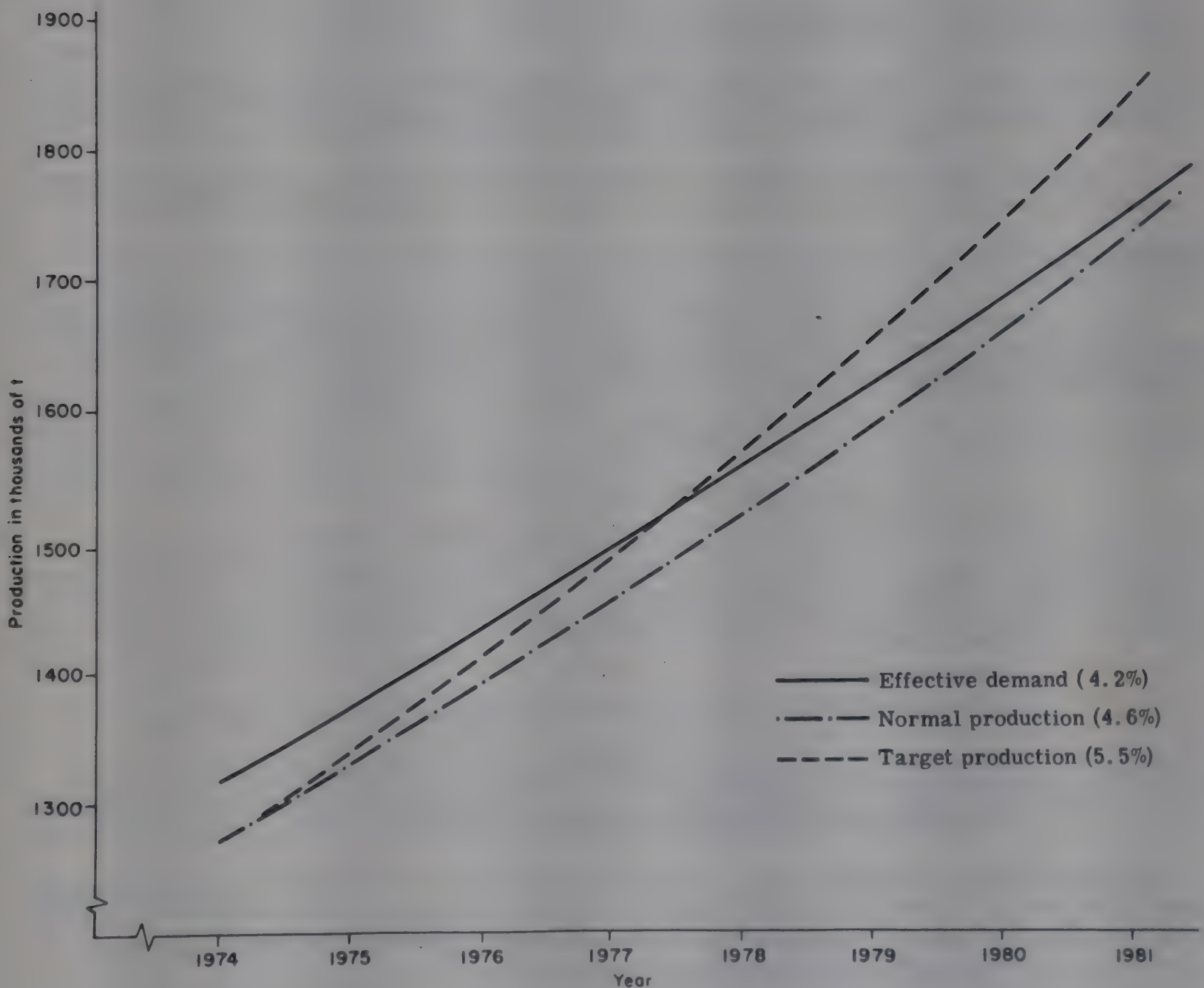


Figure 1 — Effective demand and production target, 1977–1981

METHODS FOR PROCESSING AND DISTRIBUTION OF FISH AND FISHERY PRODUCTS IN THE PHILIPPINES

by

F. Pili and Flor Abella
Bureau of Fisheries and Aquatic Resources
Intramuros, Manila, Philippines

Abstract

The majority of the fish which are landed in the Philippines are sold by auction. Crushed ice is generally used but the use of mechanical refrigeration is increasing. For distribution, fish are packed in properly insulated metal boxes or styropore boxes and transported on land by jeepneys and trucks which are well insulated and refrigerated. Retail sale of fresh fish generally takes place in the public markets, only seldom in the large grocery stores and supermarkets. Dried, smoked and fermented fish are sold in the grocery sections of the public market and in supermarkets.

There is a need to improve handling, washing and drainage of ice from fish containers. Sanitary conditions are inadequate and the use of ice often ends after the fish are landed.

Methods of fish handling, transport and storage have greatly improved over the years but further studies need to be carried out in a cooperative effort between the Government and the private sector.

INTRODUCTION

A large part of the Philippine catch is distributed and consumed in the fresh state. The annual production of fresh fish of about 1.3 million tonnes is divided into three sectors: the municipal fishery, commercial fishery and inland fishery, i.e., fishpond and brackish water (Table 1).

Table 1

Total production by fishery sector (1974)

Sector	Total catch	
	(t)	(%)
Inland fisheries	172 400	8
Municipal fisheries	621 700	53
Commercial fisheries	481 400	39
Total	1 275 500	100

Source: Expanded Fish Production Programme, 1975-76

The municipal fishery comprises about 53 percent of the total catch and employs 90 percent of the people engaged in the industry. This sector operates along all the Philippine coastline, close to the shore and delivers high quality fresh fish that is seldom more than one day old. A large part of the catch is distributed directly to the consumer through house vendors, mainly to the immediate hinterland.

The commercial fishery supplies about 30 percent of the total catch and employs about 10 percent of the people. It operates in more distant waters and the catch is delivered to more than 100 landing sites, although 85

percent of the volume is concentrated at a few landing places close to cities and urban areas. At present the inland fishery utilizes approximately 120 000 ha of fresh and brackish waters with an average catch of about 500-600 kg fish per hectare per year. This sector delivers the majority of the catch directly to the wholesale markets. Brokers, however, handle the further distribution of the catch.

These three fishery sectors play an important part in the distribution, marketing and transport of fresh fish.

HANDLING, MARKETING AND DISTRIBUTION OF FRESH FISH

The handling of fish in the Philippines consists of the following phases: (1) catching; (2) handling on board the fishing vessel; (3) handling on shore and (4) marketing which has three general stages, namely: the collection of catch, transport and distribution.

Catching

There are 10 854 powered fishing vessels and 355 nonpowered fishing vessels with an estimated number of fishermen of 44 866 (Fisheries Statistics, 1975). The fishing gears used by the commercial vessels are bag-net, beach seine, gill-net, hook and line, longline, muro-ami, push net, purse seine, trawl and round haul seine. For the municipal fishery, the fishing gears used are: fish corals, fish traps, gill-nets, hook and line, small trawl, small seine and small basnig (bag-net). This type of fishing gear affects the quality of the fish caught.

Handling on board the fishing vessel

Fish carriers and larger commercial vessels usually have insulated holds but no refrigeration facilities and carry crushed or flaked ice to chill the fish during transport. The fish holds are divided into different compartments or pens where fish are dumped in conical tubs called *bañera* with crushed ice.

After each haul, the fish are sorted according to species and size. It is the normal practice of fishermen to place their catch in tubs immediately after brailing. A tub contains approximately 30-35 kg of fish, less the weight of ice. The ice is sprinkled haphazardly over the bottom and top layer of the fish in the tub, which is then stacked in the fish hold or may remain on deck awaiting transfer to carrier boats. The proportion of ice and fish varies from 3:7 to 1:1 at the discretion of the fishermen.

The schedule for commercial fishing varies from boat to boat but generally the trawlers stay at sea for about five days before unloading, whereas purse seiners often stay at sea for about a month. The catch is usually collected by carriers, which transport the fish for reshipment or to markets, and which also deliver ice and supplies. Fish are immediately transferred to the fish carrier and placed in trays with crushed ice. If the catch is good it may take 24 h to load the carrier.

The unloading process is very tedious and may allow fish temperatures to rise considerably.

On the other hand, the municipal fishery uses mainly traditional craft, which are usually nonmechanized and operate close to the shore. These relatively small boats seldom stay out for more than one day and deliver high quality fresh fish and thus have been the basis for the Filipino preference for fresh fish.

Handling on shore

The new Navotas harbour is the first fishing harbour in the Philippines which has been built specially for the distribution of fish. As soon as the carrier arrives at the landing, the fish are unloaded by sliding the tubs down a wooden platform. Two fishermen transfer the tubs manually or by the use of hooks to a pushcart which can carry about 6-8 tubs, the cart is then brought to the main auction hall. All fish landed in Navotas market are in tubs, or wooden boxes and trays.

Some fishing vessels use plastic tubs and still others use the styropore box. The tub or bañera is the most common container: it is round with a flat bottom and tapered sides (diameter 50 cm at the top, 45 cm at the bottom, 25 cm height, and has a capacity of about 35-40 kg of fish depending upon the size of fish.) These containers can be nested when empty and thus do not take much space on board the fishing vessel. They are used mainly by the smaller Manila Bay trawlers. Since the containers are all of standard size, the fish are sold by the bañera or by the tray. The trays or kaha contain about 6-7 kg of small fish or shrimp. Large fish are weighed for sale.

Other commercial fish landing sites are listed in Table 2.

Table 2
Commercial fish landings (1975)

Landing sites	Catch landed (kg)
Navotas, Rizal	150 068 320
Cadiz, Negros	17 994 640
North Harbour, Rizal	
Iloilo City, Iloilo	80 058 560
Malabon, Rizal	23 223 410
Bacolod, Negros Occidental	71 697 590
Naga City, Camarines Sur	1 340 990
Mercedes, Camarines Norte	16 283 350
Naga, Zamboanga del Sur	75 040
Lucena City	4 673 110
Zamboanga City	8 829 040

Source: Bureau of Fisheries and Aquatic Resources, Fisheries Statistics, 1975

Fresh fish storage facilities

Fish are generally sold direct to the wholesale and retail markets and, if not sold, are placed in bañeras and held in cold store. In some areas there is a lack of ice and cold storage facilities. Ice plants and cold storage facilities have been established by the Bureau of Fisheries and Aquatic Resources which at present operates 11 ice and cold storage plants; a further 18 plants are under construction (Table 3). These ice plants will be leased eventually to the private sector. Table 4 shows the coastal refrigerated facilities in the Philippines as of June 1972.

Table 3

Bureau of Fisheries and Aquatic Resources Ice plants
Capacity, revenue and percentage utilization (1973-74)

Ice plant location	Nominal capacity (t/24 h)	Revenue (P.Ps. ^{a/})	Utilization ^{b/} (percent)
Pio Duran, Albay	10	61 343.10	22
Mercedes, Camarines Norte	10	55 701.85	21
Magalona, Negros Occidental	5	27 456.00	20
Liminangcong, Palawan	40	16 215.00	1
Masinloc, Zambales	3	12 037.00	15
Lagay, Negros Occidental	5	8 099.50	6
Sta. Ana, Cagayan	3	6 638.95	8
Dalahican, Lucena	10	1 383.30	1
Magallanes, Sorsogon	6	1 347.00	1
Barugo, Leyte	10	776.65	
Guiaun, Samar	6		
Total	108	190 998 .35	

a/ P.Ps. 1 = U.S.\$ 0.136 (April 1978)

b/ Calculated on the basis of 365 days operation a year and an assumed ice price of PPs 75/tonne

Table 4

Coastal refrigerated stores in the Philippines

Location	Capacity (m ³)
Tubigon, Bohol	410
Mercedes, Camarines Norte	56
Sta. Ana, Davao City	28
Digos, Davao del Sur	12
Iloilo City	283
Iloilo City	196
Iloilo City	283
Iloilo City	300
Iligan City	307
Manila	2 286
Manila	3
Bacolod City	193
Navotas, Rizal	7 500
Navotas, Rizal	1 090
Zamboanga City	357
Total	13 304

Source: List of Cold Storage Service under the Jurisdiction of the Public Service Commission as of 30 June 1972

Marketing

At the auction hall, the fish are received by the middlemen, mainly the brokers, vendors, consignees, agents, etc., who then sell to wholesalers and/or retailers who, in turn, re-sort the fish by species, size and quantity for sale in the metropolitan markets.

The auctioning process involves secret bidding. The buyers whisper their bids to the broker who sells the fish to the highest bidder without anyone else knowing the price. Fish transactions are to a large extent in the hands of women, both sellers (brokers) and buyers (middlemen or wholesalers and retailers).

Transport and distribution of fresh fish

The transport of fresh fish from the landing to the central markets is conducted by the producers, the buyers/brokers and the wholesalers. Only a minor portion goes by common carrier. Most of the fresh fish for the central markets is transported by sea. A major exception is the fishpond production which is brought to the market by truck or jeepney. Some of the larger operators between Navotas and northern Luzon have also developed a large company-owned trucking line. Trucks for long-distance travel are insulated but seldom refrigerated; fish carriers, since they do not have a refrigerated fish hold, often use 150-200 kg of ice for 100 kg fish. Milkfish from Iloilo and Cadiz and shrimps from Bacolod are distributed by air transport.

The conical tub (bañera) of galvanized steel is the dominant container for transport in commercial boats, carriers, on trucks and jeeps. The present overloading of jeepneys and trucks, with the tubs stacked 6-8 deep on top of each other on the bumper of a jeepney, sets special requirements for the structural strength of the tub, not usually found in other types of containers for fish. The fact that the melt water does not drain, although detrimental to the quality, nevertheless allows fish to be freighted together with other goods. The transport cost depends on the distance, availability of transport and the quality of the road/rail system. At present, the existing road network is inadequate to supply all parts of the country; the markets show markedly higher prices in the more remote areas of the Philippines.

The present marketing system

The greater part of the fish comes from the municipal fishery. The fishermen land their catch in the fishing village and the fish are sold partly by house vendors, usually members of their family. There is no official sales registration of the fish catch, hence there is no recording of the quantity of fish handled at the national level. There are some variations, however, in the sales pattern; fishing operators who own the fishing boats make arrangements with some municipal fishermen to sell their catch. Sometimes municipal fishermen sell their fish directly to the brokers since they can command a better price. The major part of the tuna catch is bought by foreign buyers and sent abroad for processing as there are no existing local canning facilities.

Middlemen's function

The role of the brokers/owners as middlemen is as follows:

- (1) To act as commission agents in the auctioning process by secret or oral bidding;
- (2) Grant credit to fishing owners, fishpond owners and wholesalers;
- (3) Collect payments;
- (4) Transport the fish sold by contractors;
- (5) Operate own fishing boat, selling own catch;
- (6) To act as buying agents for tuna, negotiating credit terms with fishermen;
- (7) Supply the fish market by buying through agents from neighbouring districts.

Sometimes the boat owners control all aspects of the business from the capture to the sale of the fish on the retail market. Brokers seem to play a very important role in the fish marketing. In some provinces, harbour

facilities are offered to boat owners by brokers who often lend out money to finance the fishing operations. More often than not, the brokers also own the fishing boat.

Marine fish

At the larger commercial landing places, like the Navotas landing, the fish are sold by auction through private brokers (commission agents) either by secret bidding or, in some places, by open oral bidding. A considerable part of the catch landed at Navotas is transported to the provinces, where fish marketing procedures differ from those in Manila. In some parts of the country the boat owners stipulate the price. A fixed brokers' commission is the general rule for large sales; for small sales the commission is usually 5 percent. The brokers are very dominant in marine fish marketing.

Freshwater fisheries

Bangus is the most important freshwater fish and part of the catch is sold at the fishpond farms or collected by buyers. However, the major part of the bangus production is delivered by the fishpond operators for sale at the various wholesale markets or at special buyers' markets.

Wholesale fish marketing (second stage)

Wholesale markets in the Manila area are at Navotas, Malabon and Divisoria. Most fishing vessels discharge fish in Navotas. The fish sold in Divisoria comes in by truck from other landing places in the south as well as by rail from the Bicol area; fish arriving by inter-island vessels is usually sold here, especially milkfish, and most of the shrimp from the province is sold here.

In the Divisoria, there is no marketing hall as the wholesale of fish takes place in the streets and sidewalks alongside the retail markets. The fish come either from Visayas by inter-island vessels or from the Bicol Region by rail. The sales procedure in Divisoria is more or less the same as in Navotas, but the fish are sold by weight (kg) instead of by *bañeras* or boxes.

The market at Malabon is the third wholesale fish market. It is entirely devoted to the sale of milkfish (*Chanos chanos*) which are brought to the markets by small bancas from nearby fishponds or by trucks and jeepneys from the provinces of Bulacan. The fish are sorted according to size and the lots are placed for sale on the concrete floor. Sale procedure is by whisper as at Navotas; the bids are per lot and not by weight. In the provinces wholesale markets exist only in the bigger cities with access to the sea. Their size is relatively small and they differ from the markets in Manila in that they practise an open auctioning system.

Wholesale markets in the provinces exist only in some of the larger cities with access to the sea and these are small compared to Navotas.

The Food Terminal Market Incorporated (FTI) operates and plays an important role in the wholesale fish marketing operation. The main objectives of FTI are to reduce and stabilize prices and improve the quality output of agricultural and fishing products. Fish supplies from North Harbour are closer to this market than to Navotas. Representatives of FTI act as buyers of fish supplies in the provinces and arrange for transportation of the fish supplies to Manila by air and cargo vessels. It has its own insulated trucks which go to the fish landing sites in Luzon and bring the fish back to Manila for wholesale marketing.

Generally, wholesalers from the provinces go by truck and jeepney to the wholesale fish markets, buy the required fish supplies through brokers and transport the fish cargo back for sale to retailers. On the other hand, supplies of bangus from the provinces are sent to the wholesale markets in Greater Manila for sale through brokers and wholesalers.

The functions of the wholesalers are as follows: grading of fish; preserving fish in ice; transportation of fish from the wholesale markets to wholesale premises; sale of fish to local retailers, financing, collection of money from local retailers, and sale and transportation of surplus supplies to local processors.

Retail fish marketing

The retail sale of fish takes place in the public central markets located all over the country, where there are special sections for selling fresh fish. The fish section is divided into stalls which are rented out to individual retailers. The fish, removed from the containers, are arranged in the stalls according to species and size. Retailers sometimes remove the ice because they are aware that the consumers dislike buying fish on ice. The supermarkets do not carry as wide a variety of fresh fish as found in the public markets; prices, however, compare favourably. Supermarkets either ice or refrigerate their fish in contrast to the practice at public markets. They also sell dried or smoked fish in plastic bags; frozen fish (bangus) is usually available and is also packed in plastic wrapping. Frozen bangus is priced much higher than fresh fish.

NEW PROCESSING METHODS AND EQUIPMENT

The fish freezing industry is growing and frozen fish has become important in both local and international trade. Freezing at sea is still in the preliminary stage. Although the fish processing industry still adheres to traditional methods, some sectors are now investing in modern fish processing facilities. The industry is characterized by entrepreneurs who operate their own freezing plants, and those who are primarily engaged in the fish trade and use commercial freezing facilities. It includes operators of tuna catching vessels and a considerable number of small volume processors who maintain an all-purpose processing area for the preparation of the fish prior to blast freezing. The industry produces frozen tuna, shrimp, lobsters and milkfish. Shrimps are frozen at an average rate of 1-2 tonnes per day; milkfish, 1-10 tonnes per day and lobster, no more than 0.5 tonnes per day.

Freeze processing is carried out without the use of sophisticated equipment and technology. Contact plate and blast freezers are the most common types used; The average independent processor would have a daily freezing capacity of 4-5 tonnes and a storage capacity of 80 tonnes. FTI owns and operates a commercial blast freezing and storage warehouse with a blast freezing capacity of 80 tonnes and a storage capacity of 300 tonnes for exporters of frozen marine products. There are other commercial blast freezing establishments in Greater Manila but their capacities are small compared to that of the FTI.

Problems

- (1) Limited capital for small processors and operators in the seafood processing business (with the exception of tuna processors).
- (2) Quality control of raw materials is not strictly carried out. Between 5 and 25 percent of the raw material arriving for processing is rejected by the processor due to improper handling, icing and sanitation practices. The high cost of ice in remote areas and mode of transport are all contributory factors to low quality.
- (3) Quality control during processing; lack of adequate supervision of the quality of the processed products.
- (4) Shortage of supply; there is an inability to tap the resources which are available.

RECOMMENDATIONS

The Philippines Fish Marketing Authority (PFMA) is a government agency with the responsibility to promote the development of the fishing industry and improve the efficiency in the handling, preservation, marketing and distribution of fish and fishery products through the establishment and operation of fishing ports, harbours and other marketing facilities. Realization of the objectives of this agency will pave the way for growth in the fishing industry.

The Bureau of Fisheries and Aquatic Resources is similarly involved in the development and improvement of fish handling practices through research studies on icing and chilling of fish, containerization, gutting, etc. Recommendations from these studies will benefit the fishing industry as a whole.

Regarding the problem of raw materials, modern methods of capturing fish should be practised in order to increase fish production. Fish prices also vary with the supply of fish in the markets.

There is urgent need to improve handling, washing, chilled and storage and hygienic conditions from the time the fish are caught until they are processed. Information should be supplied to fishermen and fish handlers who have little knowledge in this fields. Standards and specifications for quality control should be developed and strictly implemented.

REFERENCES

Bureau of Fisheries and Aquatic Resources, Fisheries Statistics, 1975, Manila
1975

MARINE PRODUCTS PROCESSING INDUSTRY IN INDIA: ITS GROWTH AND FUTURE PROSPECTS

by

R. Venkataraman and K. Devadasan
Central Institute of Fisheries Technology
Veraval, India

Abstract

The paper presents a comprehensive review of the growth of the marine products processing industry in India. It outlines the historical background, the major stages of development, the present status and problems, and the future prospects of the industry. The importance of the industry in the country's economy and the future role it is expected to play are emphasized. The weak points of the industry's present structure are pointed out and remedial steps are suggested.

INTRODUCTION

India has a coastline of nearly 5 600 km and a tradition of boat-building, but fishing and fish processing have been neglected. There were a number of reasons for this: the strong vegetarian sentiments of the people and the influence of 'Ahimsa' in the Buddhist and Jain ways of life made fishing taboo; fishing was an occupation for people in the lowest strata of society. Even today, this influence has resulted in a low exploitation of fish resources. The *per caput* consumption of fish is 3.5 kg per annum. Before independence, fisheries development did not receive the attention it deserved. Although pioneering work by the Madras Presidency in the development of fishing and fish curing, under the leadership of stalwarts like Sir F.A. Nicholson, James Hornell and Wilson, deserves special mention, systematic and organized programmes for fisheries development, at a national level, were initiated only during the post independence period.

In addition to vegetarian habits among the people there were many factors which contributed to the backwardness of the fishing industry in India. While other countries marched ahead with mechanized fishing crafts and processing methods, the marine products industry of India, under the British rule, remained stagnant with its traditional fishing methods and fishing boats, exploiting only the coastal waters. Refrigeration and the use of ice for the preservation of fish came to the Indian scene at a much later stage by which time the western world had already made tremendous advances in the field. Even the meagre catches landed were not properly utilized. Fishing villages in the coastal area were mostly inaccessible, ice was not available and proper methods for the transportation to the interior were lacking. As a result, fish, which could have been an ideal solution to the protein deficiency of the hungry millions in the interior, remained more or less a delicacy enjoyed only by the coastal population.

Realizing the importance of fish as a source of cheap and nutritious protein, and also as a potential earner of foreign exchange, the Government of India gave priority to the improvement of fishing and fish processing. As a result, the picture has changed rapidly and today marine products have become a major foreign exchange earner in the country's economy. There has also been a radical change in the eating habits of the people. The value of fish as a nutritious food is increasingly realized and fish and fishery products are no longer taboo among major sections of the population. The consumption of fish has also increased considerably.

The political independence of India in 1947 marked the beginning of a new era in the development of Indian fisheries. Five-year plans gave emphasis to the development of villages, realizing the importance of rural development in the country's economy, and the maritime states were given every encouragement to develop their fishery resources. Coastal villages were connected to the interior urban markets by metalled and tarred roads and, as a result, fisheries development programmes for the maritime states gained momentum. This was especially so on the southwest coast where, due to the peculiar oceanographic and climatic conditions, the sea was highly pro-

ductive. Oil sardines, mackerels, shrimp, etc., were landed in large quantities. Fishermen were trained in modern methods of fishing and conventional fishing gear used by the local fishermen soon gave way to new and improved gear. Nylon and other synthetic fibres replaced cotton fibres in net-making, traditional boats were equipped with outboard motors and new small mechanized boats also came onto the scene. Fishermen's Cooperatives gave an added impetus to these developments.

The Malabar coast of the Arabian Sea has rich fishery resources and became the centre of these developments; catches increased rapidly as a result of these imaginative, well-planned and organized steps taken by the Government.

FIRST STAGE

Increased landings introduced new problems; improved methods of handling, preservation, processing and transportation of the catches landed were needed. The beginning of India's modern marine products processing industry can be traced to this stage. Initially, salt-curing and sun-drying were the only common methods of preserving large quantities of fish. The importance of ice in extending the shelf-life of fresh fish was realized. Ice plants were built along the coastline and in major consumption centres both in the public and private sectors. Fresh fish became available in the nearby urban markets in an iced condition but could not be taken to the interior of the country because of the lack of proper containers or transportation. These markets relied on the supply of cured fish. The fish were cured by illiterate fishermen who were not conversant with hygienic methods of handling and processing; the quality of the cured fish was poor. Salt used by the curers was of a very poor grade; NaCl content was as low as 50 to 60 percent, the rest being fine clay.

The Government took steps to improve the quality of marine salt. A Commissioner for salt development was appointed and the Central Salt and Marine Chemical Research Institute was established at Bhavnagar in Northwest India. The Fisheries Technological Research Station was established at Kozhikode in 1948 by the Madras Government to bring about improvements in the fish processing methods and the by-products industry.

All marine salt manufacturers were licensed and they were compelled to build their factories according to improved designs. Marketing of salt with less than 97 percent NaCl content was banned and within a short period there was such an improvement that salt used by the fish curers had an NaCl content of not less than 98 percent.

In 1950 the Government of India realized the vital role that research would have to play in the development of fish production, processing and marketing. At the All-India level, the Government established the Central Institute of Fisheries Technology (CIFT) at Cochin to carry out research pertaining to boats, gear and processing technology (both fundamental and applied). The Central Marine Fisheries Research Institute (CMFRI) at Mandapam was established to deal with the biological aspects of marine fisheries and the Central Inland Fisheries Research Institute (CIFRI) was established at Calcutta for freshwater fishes.

Extensive demonstrations were conducted along the coastline by the technological laboratories and their field staff to educate the fishermen in the improved methods of fish handling and curing. Model fish curing yards were also set up at important fish landing centres. These steps made a tremendous impact on the fish curers and the quality of cured fish produced showed a remarkable improvement.

Soon, dry prawn pulp became an important export commodity to Burma, valued at I.Rs. 20 million.^{1/} Colombo-cured mackerels and sardines were already being exported to neighbouring countries, especially Sri Lanka. The fisheries technological laboratories standardized the preparation of a number of fishery products and improved their popularity. This resulted in large-scale export of important varieties of cured fish to Singapore, Sri Lanka, Mauritius and far eastern countries.

1/ I.Rs. 1 = U.S.\$ 0.12 (April 1978)

At the same time, fish guano and fish meal industries were developing. Large quantities of oil sardine (*Sardinella longiceps*), one of the main pelagic fish, were landed along the west coast from Goa to Cochin. The annual landings ranged from 150 000 to 300 000 tonnes. These large quantities posed serious handling, processing and preservation problems. Considerable quantities which could not be handled were dumped on the shore and converted into manure. The fishery technological laboratories suggested that this valuable resource could be used for making fish oil and fish meal. As a result, a large number of oil extraction plants and fish meal factories were built along the west coast. Sardine oil, of very high purity, for use by the leather tanning industry, and fish meal of high quality, suitable for feeding to poultry and cattle, were produced. Additional fishmeal plants were set up by the Governments. Although these plants faced many administrative and other problems inherent in a public sector venture, they stimulated enthusiasm among the private entrepreneurs, who soon established the basis of the fish meal industry in the country.

Sharks were another major fishery and the technological laboratories established that shark liver oil had a very high Vitamin A content. Shark liver oil factories were established at Calicut, Trivandrum, Bombay and Veral. These factories produced a very high grade of Vitamin A oil in sufficient quantities to supply the entire demands of the country. The import of large quantities of cod liver oil from Norway and other European countries was stopped.

SECOND STAGE

The advent of mechanized boats in the middle fifties was the next major step in the development of the fishing industry. Fishermen who were totally dependent on the weather for reaching the fishing ground and returning with their catch realized the advantages of propulsion by inboard and outboard engines. In collaboration with the Government of Norway and FAO, the Government of India embarked on an integrated project for the improved exploitation and utilization of the fishery resources. FAO gave valuable assistance by way of experts. These experts in fishing craft design and fishing methods gave extensive training to the technical staff of the technological institutions, such as CIFT, the Central Institute of Fisheries Operatives and the Central Institute of Fisheries Education, who then trained the local fishermen. The valuable assistance and training given by pioneers like Messrs. Miyamoto, Seiner, Illigansin and Gurtner deserve special mention in this connection. Regular training courses for fishermen in modern fishing methods were set up at institutions such as the Central Institute of Fisheries Operatives. The CIFT began detailed research studies to develop improved methods of fishing and processing suited to local conditions and fishery resources.

The fifties marked the advent of the refrigeration and canning industries on the southwest coast, where large quantities of shellfish, especially prawn and lobsters, were landed. This coincided with a boom in the export of frozen prawns and lobsters, especially to the U.S.A. As the export market developed, large and small-scale entrepreneurs established refrigeration, canning and ice factories. There was a heavy concentration of these factories in Kerala which gradually spread to the neighbouring maritime states of Karnataka, Maharashtra, Gujarat, Tamil Nadu and also to Andhra Pradesh, Orissa and West Bengal. Over the 15 years from 1960 to 1975 the export of marine products increased almost 15-fold, from I.Rs. 80 to 1 250 million. This unprecedented, phenomenal growth in the exports of marine products of India, has no parallel anywhere else in the world.

The industry had its share of teething troubles. By and large the marine products processing industry was developed by small-scale entrepreneurs. With his limited resources and stringent credit facilities, the small-scale industrialist had a tough time establishing his credibility as an exporter. The credit institutions were hesitant, initially, to finance an industry dealing with a highly perishable food item. Lack of trained and qualified technical personnel was keenly felt. Fighting against all these odds, they established themselves as exporters of high quality marine products earning substantial foreign exchange. The various technological problems faced by the industry were solved by the Central Institute of Fisheries Technology and other sister research institutions. The quality of processed products showed a remarkable improvement as a result of the stringent measures taken at various stages of processing. The Government of India also laid down quality standards for processed marine products for export based on the extensive data collected by the CIFT. Compulsory pre-shipment quality control inspection of products destined for export followed. This ensured the quality of Indian marine products sent abroad and increased their acceptance in sophisticated markets like the U.S.A. and Japan.

Table 1
Pattern of marine products exports from India (1965-1976)

Items	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Frozen shrimp	7 028 41 422	8 784 88 792	11 773 129 808	14 397 156 340	21 441 262 945	22 135 242 515	23 181 313 363	30 550 508 843	35 895 658 122	34 361 637 326	46 831 943 386	47 952 1 605 499
Frozen froglegs	443 2 624	557 5 576	786 8 817	452 4 891	854 11 890	2 545 32 899	1 451 13 774	1 823 21 709	2 698 44 979	1 454 28 652	1 317 27 983	3 170 77 970
Frozen lobster tails	112 1 274	81 1 474	128 2 337	297 6 684	529 11 224	382 6 021	326 10 942	369 12 794	380 10 663	456 12 573	402 15 760	513 31 802
Frozen fish	8 30	2 25	2 12	5 50	16 119	6 42	24 131	21 123	146 731	66 767	134 1 884	1 583 16 383
Frozen cuttlefish	— —	— —	— —	— —	— —	— —	— —	— —	14 190	141 1 979	1 017 29 071	648 13 334
Canned shrimp	1 148 9 506	1 523 18 656	2 200 31 243	2 238 26 156	1 661 22 104	2 578 39 541	1 864 29 757	1 058 21 026	2 199 52 369	1 516 47 842	261 5 999	102 3 935
Dried shrimp	1 702 5 447	1 163 5 271	1 540 8 961	1 411 7 259	835 4 840	1 486 8 361	684 3 742	139 1 380	284 3 230	116 1 426	99 1 132	36 385
Dried fish	4 431 6 522	6 551 13 246	5 147 13 238	5 388 14 045	4 329 11 658	7 269 18 368	5 941 13 820	3 478 7 971	3 388 10 955	1 748 6 658	2 295 9 061	4 668 17 341
Shark fins and maws	244 2 032	139 1 340	296 3 709	331 4 690	214 4 551	282 5 998	295 5 189	294 6 027	254 6 569	259 8 464	307 9 822	268 15 294
Other items	341 310	139 866	492 1 141	291 731	705 1 400	491 1 614	266 1 007	539 1 444	3 530 7 955	6 512 17 440	749 4 965	3 211 15 677
Total	15 457 69 167	18 959 135 246	22 364 199 286	24 810 200 846	30 584 330 731	37 175 355 359	34 032 391 725	38 271 581 317	48 788 795 763	46 623 763 127	53 412 1 049 063	62 151 1 798 620

a/ Q = Quantity in tonnes of product weight

b/ V = Value in I.Rs. '000

At this stage, frozen froglegs were added to the list of exported fish products. Frogs, which are plentiful in the marshy areas and water-logged paddy fields of the southwest coast, are not eaten by the local population. However, the prospects for their export to the U.S.A' and France made them a very valuable commodity. Frogs were caught in such large quantities that it was necessary for the Government to take suitable conservation measures by banning frog-catching during the breeding season. The high incidence of pathogenic bacteria, e.g., *Salmonella*, in frogs caught from marshy areas posed a technological challenge to the comparatively new processors, but with guidance from the technological laboratory, they soon mastered the techniques for processing good quality frozen froglegs. In due course frozen cuttlefish and squid also became export items. This was a welcome development in that a commodity which was not used became a valuable export product which gave a very good return to the fishermen.

The steady increase in the export during the past 12 years is clear from Table 1. However, a disturbing factor is that prawns, which constitutes about 10-15 percent of the total marine landings of the country, account for almost 80-90 percent of the foreign exchange earnings from the marine products industry. Indian coastal waters abound in a variety of highly relished table fish but no systematic effort has been made to process these fish into exportable products. The Government of India has made some efforts in this direction by subsidizing attempts to produce canned oil sardine, the largest single fishery of the country, but the response from the private industry was not encouraging.

This overdependence on shellfish and froglegs has been brought to the attention of the marine processors by the CIFT and other agencies of the Government of India. The slogan 'Export or perish' has been changed to 'Diversify exports or perish'. As a result, isolated attempts have been made, especially along the Gujarat coast, to export frozen pomfrets, *Hilsa*, etc., to the Gulf countries and this is bringing in valuable foreign exchange. It is hoped that this trend to diversify production and to explore new markets will mark the beginning of a new chapter in the history of India's marine products processing industry. So far the export industry has been totally dependent on three commodities and restricted to the American and Japanese markets; the vast potential in European and Gulf countries remains untapped. Once the prawn fishery (which of late is showing distressing trends of decline in several areas along the west coast) fails, the industry in its present set-up will collapse. However, the danger signs have been noticed and every opportunity is being taken by the various Government agencies and other enlightened processors, to instruct the trade that, from now on, they should make an all-out effort to diversify their export of marine products. This drive has already yielded encouraging results.

The recent declaration of the Government of India of an exclusive economic zone of 200 mi has increased the fish catch potential. Survey attempts are also intensified in collaboration with countries like Poland. These steps should bring in a new era of deep-sea fishing in India. For deep-sea fishing, however, improved fishing harbours, bigger and better boats and trained personnel who can man these boats are needed. With the aid of agencies, such as the World Bank, and technical collaboration with leading maritime countries. The Government is trying to provide these facilities. Importance has been given to programmes for the development of fisheries in the sixth five-year plan. The marine products processing industry is fully export-oriented and has become a major earner of foreign exchange (Table 1). This has given it a special status in Government development plans. An organized and systematic exploitation of the deep-sea fishery resources has, however, yet to make progress in India. Fishing with large factory vessels with onboard processing facilities has not started and often poaching by foreign vessels from India's territorial waters is reported.

The canning industry made a good start in the early sixties, and many factories were built along the Kerala coast. These factories canned prawns only; in spite of the availability of a wide variety of other table fishes which could be successfully canned, no attempts were made to can them. The CIFT standardized the methods for canning a variety of such products but the industry was reluctant to venture into commercial production. The prohibitive cost of the cans prevented many entrepreneurs from establishing fish canning factories. Since the marine products industry is still dependent to a large extent on frozen prawn, lobster and froglegs the importance of diversification of products and markets cannot be overemphasized. Realizing these facts the Government has already set up a Marine Products Export Development Authority, with its headquarters at Cochin, which is looking into these problems.

TECHNOLOGICAL DEVELOPMENTS

Another interesting feature of the development of fisheries in India is that the majority of processed marine products are exported. The home market depends mainly on the freshwater fishes available in nearby reservoirs, rivers, major and minor irrigation canals, etc. Recently, through the pioneering work of CIFT, cheap and improved containers for transporting fresh fish in prime condition inland have been developed.

In spite of the advances made by the freezing industry curing is still perhaps the favourite method of fish preservation. This is particularly so for fish such as mackerel, Bombay duck, sciaenids, etc. Through the years the hygienic standards of these products have improved enormously. Drying, however, is mainly conventional sun-drying and the fish are contaminated with sand, dust, etc; contamination with red halophilic bacteria is frequently encountered. As a result of sustained efforts by the CIFT, improved methods of curing have become more widespread. Low-cost artificial driers for producing good quality dried fishery products are becoming popular and have been erected in major fish curing centres. Also, efforts have been made to design suitable low-cost solar driers.

Dried products with improved storage life and consumer appeal, e.g., laminated Bombay duck, are rapidly gaining acceptance by the local fish processors. However, it is to be observed that the dry fish industry in India is, by and large, still in need of modernization.

Another major problem which the fishery technologists and the Government are tackling is the considerable wastage of the by-catch, i.e., fish which are not relished as food and which fetch a poor return to the fishermen; this amounts to more than 25 percent of the total landings. These fish are mostly used as manure or poultry feed. This is a regrettable wastage of valuable protein which India cannot afford. The Central Institute of Fisheries Technology has developed various methods of utilizing the by-catch to make edible products, e.g., fish protein concentrate, fish powder, etc. Methods have been developed for the utilization of waste materials from fish processing factories. These methods are gaining approval and acceptance and, in the near future, many of these processes are likely to be commercially exploited.

The cooperative sector has played an important role in the development of many consumer industries in India, e.g., dairy products, sugar, etc. For fisheries, with certain exceptions, cooperatives have not played a significant role. This was mainly due to the absence of leadership. The average fisherman is illiterate and cannot manage a cooperative venture properly, whereas in the other fields, the cooperators are better educated. However, this situation is changing fast as a result of intensive training given to the fishermen in cooperative management.

Fish marketing in India is not well organized at present. Often the middleman takes the bulk of the profits and denies the fisherman his share. Fisheries cooperatives are the only solution to this problem, but as mentioned earlier, cooperatives have yet to make their impact in this field.

In addition to the marine fishery resources, India is blessed with innumerable rivers, lakes, estuaries, lagoons, etc., which abound with a wide variety of fish, and with reservoirs, irrigation tanks, ponds, etc., which could be used for fish culture.

The Brahmaputra, Ganges, Mahanadi, Godavari, Krishna and Cauveri, on the east coast and Narmada and Tapi on the west coast have substantial estuarine fisheries. Lakes such as Chilka and Pulicat and the backwaters of Kerala are also highly productive. Species such as *Hilsa ilisha*, *Chanos chanos*, mullets, catfishes, perches, etc., which can adjust to varying salinities are the main fisheries in these estuaries. Embanked brackish waters with artificial walls are another source of fish in several parts of the country especially in Bengal and Kerala. This reclaimed land is generally used for one crop of paddy and then it is used for fish culture. Prawns, mullets, pearl spots, etc., are the most important varieties harvested from such areas. The Central Inland Fisheries Research Institute has set up large fish farms for culturing brackish-water fish in several parts of the country. Tilapia, milkfish, mullet, etc., are cultured.

Among the freshwater fish, carps, e.g., rohu, catla, mrigal are the important species. Under the guidance of CIFRI, Fisheries Departments of various State Governments have recently introduced extensive schemes for induced breeding, stocking, culture and capture of these fish in the reservoirs. This has been highly successful in several parts of the country. Culture of freshwater fish in domestic ponds and wells is a traditional practice in India especially in Bengal, Bihar and Tamil Nadu. Many State Fisheries Departments have now adopted systematic programmes for improving such resources by training the public in scientific methods of breeding, culturing and stocking. As a result, freshwater fish production has increased tremendously.

CONCLUSIONS

With its newly defined 200-mi exclusive economic zone and its vast freshwater fishery resources, India has tremendous potential to become one of the foremost fish-producing countries of the world. On a very conservative estimate, the Indian Ocean alone can yield 10-12 million tonnes of fish annually. India has made a humble beginning in the exploitation of these resources but it can be safely said that the country is already on the threshold of a 'fish boom' or what may be termed a 'blue revolution'.

In recent years, as a result of well-planned and sustained efforts by the agricultural scientists and the Government, the country has had a 'green revolution' in agriculture and a 'white revolution' in dairy products is on its way. The fishery technologists of the country are keen to supplement these with a 'blue revolution', thereby banishing the curse of malnutrition from the face of India. Although this is only a beginning, the country is fast marching toward that goal.

THE FISH PROCESSING INDUSTRY IN PENINSULAR MALAYSIA

by

Mohd. Ismail Abdullah and Ahmed Zaharudin Idrus
MARDI, Serdang, Selangor, Malaysia

Abstract

Fish is important in the diet of Malaysians and most ASEAN countries; it provides approximately 49 percent of the total animal protein consumed and 12 percent of the total protein intake. The availability of fish depends on the number of boats and quantity of fish caught per boat. However, the losses due to poor handling, transportation, storage and related facilities could easily amount to approximately 30 percent of the total landing.

Fishery products and methods of processing are considered. The status of existing technology is also assessed, although this is difficult due to the rapid expansion and development of certain sectors of the industry. The growth of the processing and utilization industry has increased the need for improved technology and consequently research and development is needed to support the growth of the industry.

INTRODUCTION

Fish provides approximately 49 percent of the total animal protein consumed and 12 percent of the total protein intake in the Malaysian diet. A similar pattern is observed in other ASEAN countries where approximately 20-30 kg of fish are consumed each year. Fishing provides a livelihood to over 90 500 fishermen and although the number of unlicensed boats and part-time fishermen is difficult to estimate, there are approximately 22 147 licensed boats (inclusive of powered and unpowered boats); a growth rate of about 2.6 percent per annum has been reported (Economic Report, 1977)

Fishing in Malaysia is based largely on pelagic species. Although the continental shelf extends 40-100 mi from the shore, fishing activity is confined mainly to a narrow strip of water extending some 15 mi seaward. An exception to this is the cage trap fishery (bubu) which is operated some 40 mi off-shore and exploits demersal species such as red snapper (ikan merah) and cat fish (ikan duri), etc.

Losses due to poor handling, transportation, storage and related facilities are approximately 30 percent of the total landing.

STATUS OF THE INDUSTRY

The availability of fish in Peninsular Malaysia has increased substantially from 19000 to 302 606 tonnes, during the period 1959-69. This could be attributed to the increased use of powered boats. However, in 1975, there was a slight decrease in the total landings of 375 000 tonnes as seen in Fig. 1. Kamari *et al.* (1977) had also projected the total demand for fish as shown in Fig. 2.

The production of fish as a whole is affected by the number of fishing boats and the quality of fish caught per boat. Wahby *et al.* (1970) stated that the catch is dependent on:

- (1) Size of boat
- (2) Engine horsepower
- (3) Type of gear used, determining the type of fish caught
- (4) Performance and efficiency of fishing crew
- (5) Area of fishing ground covered and its potential production capability.

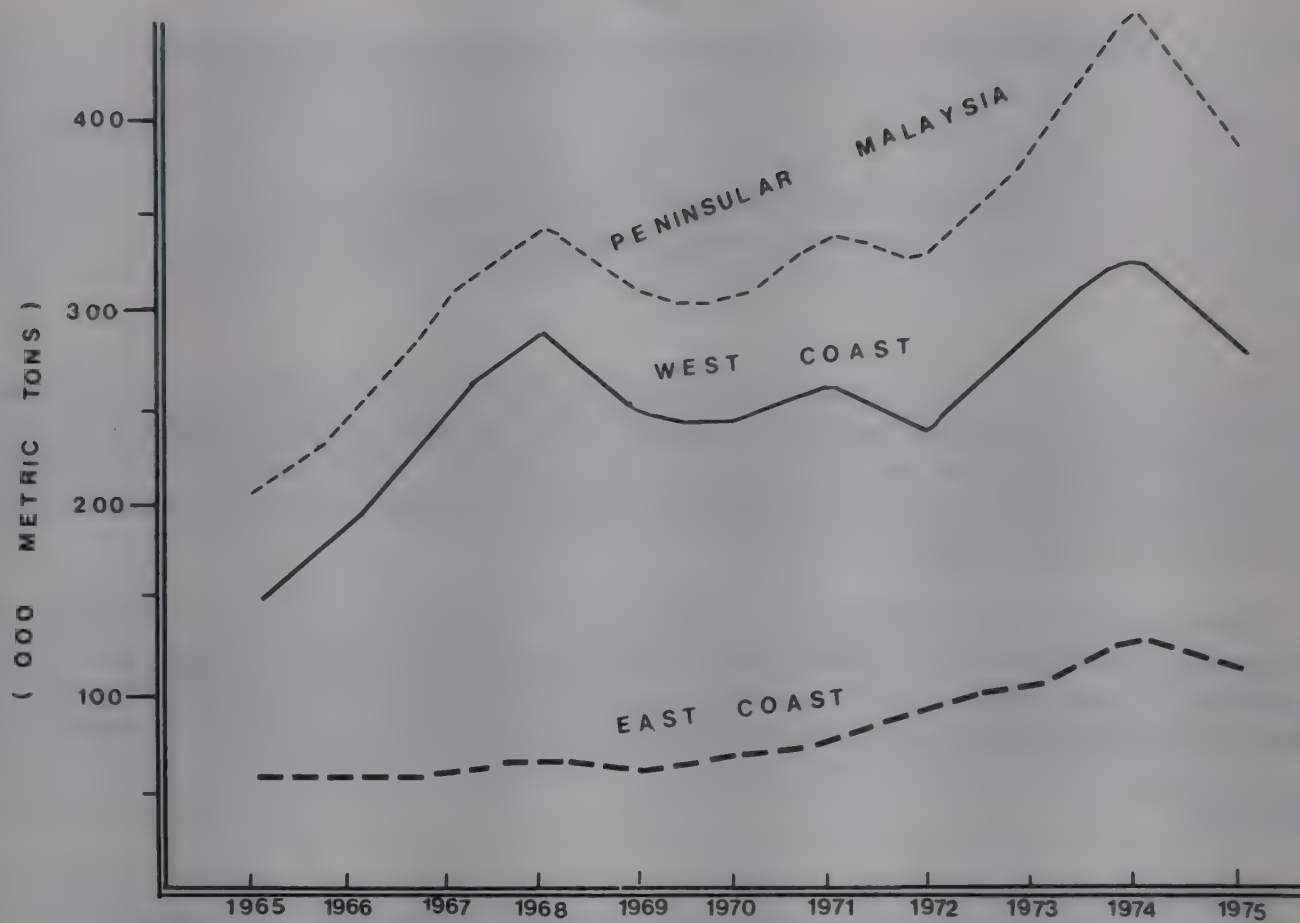


Fig. 1 — Quantity of marine fish landed in Peninsular Malaysia for the period 1965–1975.
(Source: Fisheries Statistics 1975)

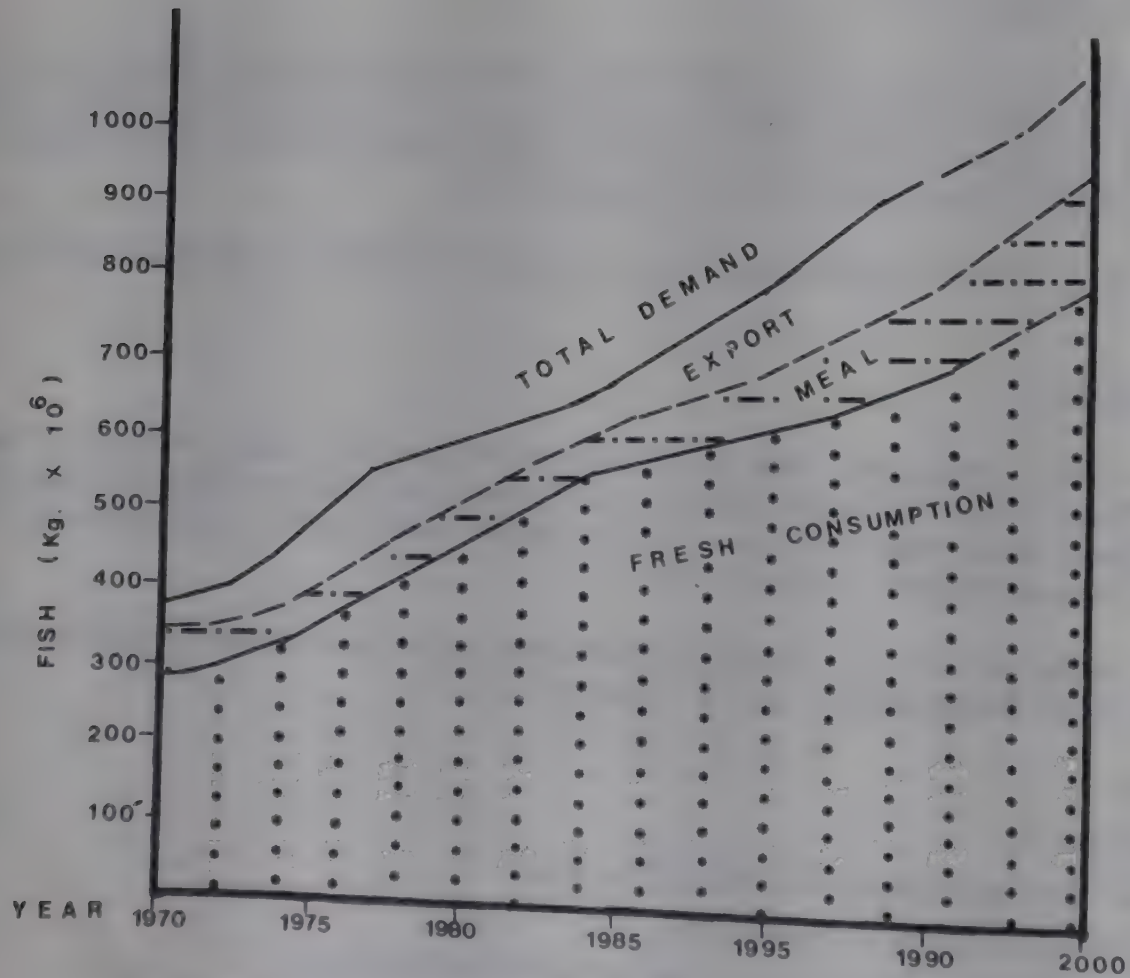


Fig. 2 — Projected demand for fish in Malaysia 1970–1995.
(Kamari *et al.*, 1976)

Table 1

Number and categories of inboard fishing boats in 1968 and 1975

Description	1968	1975
<i>Length of boats</i>		
Under 25 ft	1 147	1 015
25-39 ft	7 678	11 213
40-54 ft	1 369	3 157
55 ft and over	415	736
Total	10 629	16 121
<i>Tonnage</i>		
Under 15 t	9 499	13 181
15-29 t	750	1 665
30-44 t	197	1 092
45-59 t	173	161
60 t	10	22
Total	10 629	16 121
<i>HP of engines</i>		
Under 10	5 851	5 166
10-19	1 900	2 691
20-39	1 406	5 166
40-59	258	555
60-79	453	275
80-99	251	180
100 and over	510	2 088
Total	10 629	16 121
<i>Gears employed</i>		
Fishing stakes (large)	147	42
Fishing stakes (small)	66	16
Seine nets	1 774	2 651
Gill drift-nets	4 623	5 679
Lift-nets	734	462
Push-nets	1	17
Bag-nets	419	418
Lines	1 973	2 210
Traps and pots	347	402
Shellfish collection	71	158
Miscellaneous	15	22
Trawler net	210	2 833
Fish carrier	276	101
Total	10 629	16 121

Table 2

Number and categories of outboard fishing boats in 1968 and 1975

Description	1968	1975
<i>Length of boats</i>		
Under 25 ft	2 263	1 955
25-39 ft t	264	161
40-54 ft t	3	1
55 ft and over	1	
Total	2 531	2 126
<i>HP of engine</i>		
Under 5	2 055	1 711
5-9	360	239
10-14	78	
15-19	23	135
20-24	8	
25 and over	7	31
Total	2 531	2 126
<i>Gears employed</i>		
Fishing stakes (large)	62	60
Fishing stakes (small)	39	23
Seine nets	158	147
Gill drift-nets	941	882
Lift-nets	26	56
Push-nets	49	30
Bag-nets	295	218
Barrier nets	29	33
Lines	832	569
Traps and pots	22	25
Shellfish collection	12	11
Miscellaneous	32	37
Fish carrier	34	25
Total	2 531	2 126

Table 3

Fishing boats licensed in West Malaysia in 1968 and 1975

Type of boats	1968	1975
Non-powered	6 293	3 896
Powered, outboard	2 531	2 126
Powered, inboard	10 629	16 121
Total	19 453	22 143

Boats

From Tables 1, 2 and 3 it can be seen that from 1968 to 1975 the total number of boats has increased; the number of powered boats has increased while the use of non-powered boats decreased. It also appears that in-board engines are preferred to outboard motors. This corresponds to the net increase in total fish caught over the same period. However, it can be readily seen that the Malaysian fleet is essentially a small-boat fishery, significant proportion of which is still not mechanized and of those which are mechanized, the majority have low-powered engines.

There are recognized centres for landing and processing fish on the east and west coasts which are normally associated with the town, or settlements of the fishermen. However, there are many small villages along the coast where the fishermen do not provide data on total landings and the significance of these catches cannot be assessed.

Gears

In larger fishing centres, e.g., the Fisheries Development Authority Landing Complexes, there are many, large well-designed boats. Many of these boats fish with seine nets. The fish are attracted by lures made from coconut branches and surface lights. Such an operation usually requires two large powered boats and one or two sampans. The crew may number 20-30 and, since they share the catch equally, after certain deductions have been made, the individual shares are not high.

Other traditional gears used are fishing stakes (large and small) lift-nets, push-nets, bag-nets, barrier nets and lines, pots and traps. Most of these, except the traps, have a low catching ability, are labour-intensive and, because of their semi-permanent nature, are vulnerable to monsoon damage. However, large quantities of the valuable red snapper, catfish, jewfish, groupers, etc., are caught in traps which have the advantage that they can be used for fishing in deep waters around rocks where nets are not suitable. They are, however, subject to storm damage.

By far the most productive gear is the trawl net which accounted for 182 888 tonnes from a total of 375 235 tonnes in 1975. The term trawler as used in Malaysia is applied to a large number of small- to medium-size boats using either beam trawls (often used for prawns) or other trawls. The otter gear is the most common. There are some larger trawlers (21-24 m) but these, like the small trawlers, confine their activities to inshore fishing, all return daily to land their catches. The trawlers, therefore, are competing for the same stocks of fish as the traditional boats. Since they operate in relatively shallow water, the catch includes a high percentage of small fish, much of which is converted to fish meal.

There is a good deal of resentment toward the trawler fishermen by traditional fishermen. Although it has been Government policy in the past to curtail trawling operations, the Government is continuing with its policy of developing off-shore trawling. New exploration and research vessels have recently been commissioned to survey the off-shore waters along both coasts.

The second most productive gear is the seine net which in 1975 accounted for 67 667 tonnes. Seine nets are used for several different types of fishing, e.g., for anchovies and night fishing, but in all cases the design and operation of the gear is similar. Almost two thirds of the total fish landed were caught by trawl or seine nets.

The continued exploitation of pelagic species over the narrow coastal strip is not likely to result in greatly increased landings. The lack of emphasis on conservation and poor management have greatly depleted the fish resources, especially since the introduction of more efficient fishing methods (Sivalingam, 1977).

Ice

One of the problems facing a fishing fleet which remains at sea for several days is the availability of ice. The larger boats based at places where ice is available take ice to sea with them but in outlying villages ice is very costly (M.\$ 50-M.\$ 55^a/ per tonne). Thus, fishermen in villages which are far from the ice factory do not buy ice.

There are 83 ice plants scattered throughout Malaysia but the daily output of many of them is small (Fisheries Statistics, 1975). The total capacity is 2 531 tonnes or 62 255 blocks per day. Storage capacity is about 4 500 tonnes.

Handling practices

On vessels

There is considerable variation in the methods of handling fish on board the fishing vessels. All the trawlers are fitted with an insulated fish hold or ice box and, in many cases, the hold is divided so that fish of different grades can be separated on board. The insulation of these boxes, however, is less than adequate because the insulating material is not thick enough. Also, fish caught at the beginning of a 5-day trip are mixed with the final catch, thus affecting the quality of the latter. There are two main reasons for the poor quality of trawl-caught fish which are landed on the west coast: ice is not properly applied, and insufficient ice is used.

As an alternative to using ice, a number of boats have been fitted with refrigerated sea-water holds. The holds, measuring 1.2 x 1.2 x 1.83 m are fitted with 12 mm diameter copper grids on all sides except the top and bottom. The boats are fitted with 4 hp compressors which are belt-driven from the main engine through a second hand gear box.

One of the reasons for installing refrigeration units is that a 200 lb ice block now costs M.\$ 5.00. The refrigeration equipment is installed at a total cost of about M.\$ 6 000. With ice costing M.\$ 50-55 per trip, the refrigeration system can be paid for in 120 trips or 18-24 months. Refrigerated sea water is rarely used elsewhere, even experimentally, for the storage of trawled white fish (Cole, 1977). There are two reasons for this: firstly, ice is regarded as a relatively cheap commodity and it would usually be more profitable to stow fish in ice than attempt to use sea water; secondly, there is a danger that fish will take up salt from the refrigerated sea water and reduce the quality. Handling of fish on smaller vessels is not much better. Some of the very smallest boats are not fitted with any kind of fish hold or ice box.

On shore

Fish which have been stored in melting ice are commonly off-loaded by hand, sorted into boxes or baskets and then carried ashore. This is the practice in the smaller handline and trap fishing vessels and in some of the smaller trawlers. Fish which have been stored in chilled sea water are commonly removed from the holds by brailing or scooping out the fish with a net; often the fish are almost at ambient temperature (29°C) because insufficient ice was used. In most ports, after off-loading, the fish are stored with limited or no ice and are often taken to the market, or for packaging, with limited ice.

Transport by road

Cheaply produced and often non-returnable wooden boxes are used to carry fish. The box is lined with light gauge polythene sheet; a layer of ice is spread over the bottom and alternate layers of fish and ice are added until the box is full. The amount of ice used depends on the distance of transportation; large and expensive fish are generally packed more carefully than are the smaller varieties. The packing is usually efficient and the fish arrive in excellent condition after an overnight journey from the port to the wholesale market.

Road transport is invariably in open lorries, covered with tarpaulin, which usually travel at night. The lorries are not insulated and, in consequence, much ice is wasted. In some cases the lorries are used one day for fruits, another day for dried goods, etc., but many lorries are used only for carrying fish in ice or blocks of ice. Insulated lorries would reduce meltage of ice and therefore help to reduce spoilage of fish but, before a recommendation is made for their use, an economic appraisal must be carried out.

Recommendations

The following recommendations are made which, if implemented, could lead to an improvement in the fishing industry:

- (a) The establishment of a deep-sea trawling fleet to exploit off-shore waters to diversify the efforts of the fishermen should be actively pursued.
- (b) Trawlers should be designed to stay at sea for several days; the hold should be capable of carrying ice and fish from several days' fishing.
- (c) Larger fish should be gutted and washed in the shade, before storage in ice in the holds.
- (d) Fishing aids, such as radar, echo sounder, navigators, etc., should be installed in all distant-water trawlers. This would enable systematic scouting surveys to be carried out.
- (e) More ice should be available at lower prices to fishermen. All fishermen should be trained in the correct use of ice for preserving fish aboard boats.

The processing industry

Table 4

Marine fish products in 1975
Adapted from Annual Fisheries Statistics, 1976

Product	Amount in tonnes
Dried salted fish	7 827
Dried anchovies	5 490
Boiled fish	242
Marine fish	15 628
Fish meal	12 006
Dried prawns	1 502
Prawn dust	222
Prawn paste	1 200
Fish crackers))	
Prawn crackers)	367
Prawn sauce	095
Smoked tuna	51
Peeled prawns	561
Jellyfish	66
Cuttlefish	65
Total	45 227.95

From Table 4 it can be seen that, in Peninsular Malaysia much of the catch was processed into one or another of the traditional products. Salted and dried fish products (including anchovies) utilize the bulk of the fresh which is processed for edible purposes, i.e., 13 317 tonnes out of 45 227 tonnes or 29.4 percent. On finished product basis, these products account for 77 percent of the total edible output of processed fish.

Fish utilization technology

The last survey to assess existing technology was conducted in 1970 (Wahby *et al.*, 1970). In the last five years, however, it is estimated that the frozen sea-food industry has increased by about 40 percent. In 1976 there

were about 47 frozen shrimp factories in operation (Merican *et al.*, 1977). The other processing industries continue with only a slight increase. The technology for fresh fish preservation has not kept pace with the growth of fish landings and the demand for fish.

The approach to research in fish preservation and related aspects should be tackled from a slightly different angle from that of the developed temperate region (Kreuzer, 1965). These problems have also been discussed internationally (Tropical Products Institute Conference, 1976). However, a brief discussion on certain aspects of existing technology in Malaysia is desirable in order to understand the problems and to make recommendations for their solution. In considering technological progress, three broad areas have to be considered: (a) handling and processing at sea; (b) the application of physico-chemical principles to improve the end products, and (c) the concept of quality control (as well as sanitation and hygiene) that is applied during processing and the final quality of the product.

Kamari *et al.* (1977) and Merican *et al.* (1977) have made preliminary examinations of the quality deterioration that occurs between capture and marketing and its associated problems. Briefly the problems are: (i) handling on board ships where there is a need for improved designs of holds; (ii) handling or landing centres; at the wholesale and retail markets the fish must never be exposed to high temperatures or the unhygienic conditions of the environment. This is an area that requires urgent attention since the quality of the raw material, before it is processed, will determine the quality of the end product.

Frozen products

At present freezing of fish is very limited and, as in other countries where fresh fish is readily available to most of the population, a prejudice exists against frozen fish with increasing urbanization, frozen foods in general will become more popular and eventually this prejudice will be overcome. Meanwhile there is a potential export market for good quality frozen fish and shellfish. Freezing could also be utilized to preserve certain valuable species, which are sometimes available in 'glut' quantities, for sale at a later date. It is to be expected, however, that if increased landings from the development on the east coast materialize, it would be advantageous to freeze fish caught at times of 'glut' for release on the market when fresh fish are scarce.

Prawns

The export of frozen prawns from Malaysia is now an established industry. During the peak period of 1973 there were as many as 47 companies exporting frozen prawns (Merican, personal communication). There are many species of crustaceans in Malaysian waters and local names, based on colour patterns, are used. These are recognized in international trade, e.g., tiger stripe, white, brown, green or pink.

Prawns are taken principally by trawl, seine and bag-nets; these gears account for 75 percent of the landings. The prawns are sorted from the trash fish and delivered to the freezing plants in boxes.

Small prawns may be peeled at the point of landing and delivered in ice to the packers. Grading is done mainly by hand. Size-grading is particularly important since the prawns are used for various purposes by importers as, for instance, cocktail prawns, fried prawns, salted prawns, etc.

After size-grading, the prawns may be treated in a variety of ways according to the market for which they are destined. Some may be frozen whole, others are beheaded before freezing, and others are peeled and deveined before freezing. A considerable amount of prawns are boiled before peeling; small quantities of whole prawns are boiled in a 5-6 percent salt solution.

After processing, the prawns are ready for packing and freezing. They are usually frozen in blocks. Some packers freeze them directly in cartons using contact plate freezers, others freeze them in covered metal trays in a blast freezer. Once frozen, the blocks must be protected from dehydration. The blocks are knocked out of the

tray and immersed in cold water; this produces a glaze over the whole surface. If the prawns are frozen directly in cartons, they cannot be readily glazed. Therefore, water is poured into the carton after the correct weight of prawns has been packed into it. This spreads through the block encasing them in ice.

It can be seen that these processes demand a certain amount of handling. The prawns, when delivered, are usually a few hours old; the initial contamination is high and since bacteriological deterioration takes place rapidly, the bacterial load may increase further and spread through the whole mass during peeling, heading, etc.

High bacterial counts, particularly coliform and coagulase-positive staphylococci are the chief cause of rejection in overseas markets (Merican *et al.*, 1977). In their efforts to counteract these high counts, the packers keep the prawns iced at all stages of production and subject them to repeated washing with 5 ppm chlorinated water. Some of the established prawn processing plants in Malaysia are of modern design, while the rest will undergo improvement. The markets for these products, mainly Europe, Japan and America, are well established and the specifications are fairly uniform.

Fillets

Some of the plants which freeze prawns are beginning to experiment with frozen fish fillets for export to the U.S.A. and Europe. At present, only a few species in the low or medium price range such as red snapper, catfish and threadfin bream are used.

Techniques for cutting fillets, freezing and packing are not well established. The high price of suitable species on the market is one factor retarding the growth of this industry. The establishment of a deep-sea trawling industry would no doubt yield more fish suitable for filleting.

Whole fish

The freezing of higher-priced species in time of abundance, when the purchase price may be low, for release as 'fresh' fish during periods of scarcity has been carried out successfully by some packers. Also, dried salted fish, which are processed before the monsoon on the east coast, are kept in chilled storage in increasing quantities. During periods of 'glut', the demand for some species is low and they command a lower price. Many of them are salted and this results in a loss of revenue. Freezing of these fish at or near the point of landing could make them available at a later date in distant markets.

However, in order to expand the industry, certain processing techniques will have to be followed to avoid the marketing of inferior products and the consequent resistance to frozen fish.

Fish held in cold storage for any period are subject to certain changes such as dehydration and rancidity which impair their flavour and texture. Slow protein denaturation also takes place making the flesh tough and fibrous (Love, 1956). While most of these changes cannot be prevented, they can be retarded considerably by adequate glazing, lower storage temperature (-30°C) and the use of antioxidants.

Fish curing

Fish curing includes the following processes:

- (a) Salting
- (b) Drying
- (c) Smoking
- (d) Fermentation
- (e) Others, e.g., semi-conserves or marinades in vinegar

Salted and dried fish

In Malaysia, fish which are not likely to fetch good prices in the fresh state are salted and dried. Because it is a relatively simple method of preservation, dried salted fish has become a staple food. Chub mackerel, herring, catfish, threadfin bream, grouper, red snapper are some of the species which are commonly salted. Bonito, Spanish mackerel and squid are also salted and dried at times.

The equipment which is used is very simple, i.e., concrete vats for salting, often protected by a roof and some bamboo staging, usually erected close to the beach or over the water along the river mouths. The products are sometimes covered by bamboo matting to protect them from rain.

The stages in salting are:

- (1) Removal of guts
- (2) Sometimes splitting and opening butterfly fashion
- (3) Alternate layers of coarse solar salt and fish are placed in the vats
- (4) When the vat is full a heavier layer of salt is placed on top (total weight of salt used = 50 percent of weight of fish)
- (5) Fish are left for 2 to 6 days depending on the size of the fish
- (6) On completion of salting, the fish are washed to remove adhering salt; they are spread out to dry and turned periodically.

Much of the salt-cured fish made in Malaysia is of very high quality and the products are well liked by the consumers. As road transport has become easier and ice more readily available, the amount of fish which is salted has decreased. Although it is expected that this tendency will continue, there will none the less always be a consumer demand for some salt-cured fish.

Where the products are not of high quality, improved hygiene and attention to detail of preparation are the principal needs. Many of the products are partially fermented; there would appear to be no advantages to be gained either by using salt of greater purity or by attempting to dry the products artificially.

Ikan bilis

Ikan bilis is another sun-dried product which is made from small anchovies (*Stolephorus* spp.). These fish, which are about 2.5-5 cm in length are caught in large quantities by special purse seines in the coastal waters around Malaysia. Essentially, the process consists of boiling the anchovies for a short time in 10 percent salt water and then spreading them in the sun to dry. Formerly this was carried out entirely on the shore and, on the east coast, much of it is still handled in this way. Once taken from the net, the fish spoil rapidly under the prevailing high temperature (29°C) and, within a short time, become soft and reddish in colour. Such fish result in inferior products, which fetch a much lower price.

On the west coast, anchovies are boiled on board a processing boat which accompanies four or five catcher boats. Many of these are large seine netters, formerly used in the chub mackerel fishery. The product is usually superior because the anchovies are cooked almost immediately after being taken from the net. In addition, the catching boats are able to remain at sea for longer periods and thus make bigger catches. Since the flesh is denatured in boiling, drying can be at a much higher temperature than with dried salt fish.

Ikan bilis is normally sold to wholesalers who supply to retail outlets either in the loose form or in polythene packs. Little spoilage occurs during this period due to the low moisture content (approximately 6 percent).

Smoked fish

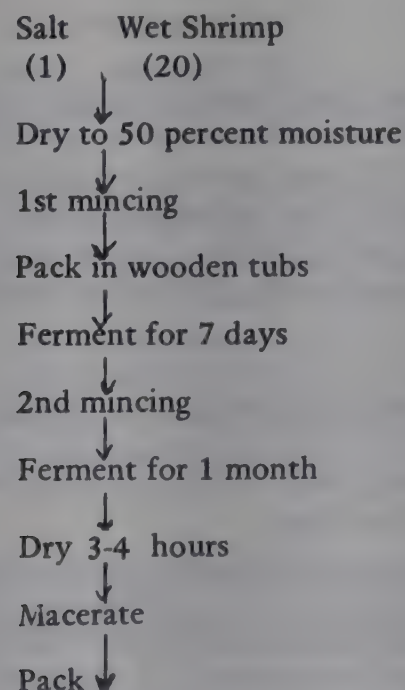
Fish smoking is not common in Malaysia. In 1975, only 52 tonnes of smoked fish (mainly tuna) were made in the state of Trengganu. The products are mainly for export to Japan. The future of the industry depends having on the supply of tuna which is more usually processed into canned products.

Fermented products

Belacan (shrimp paste)

Belacan is a common product, in Malaysia and South East Asia. It is a condiment produced by salt-controlled anaerobic fermentation of mysid shrimps. The technique of production varies, resulting in products that vary widely in composition and quality. Considerable quantities are produced in fishing villages using crude methods. The following chart demonstrates the stages in processing.

Belacan preparation



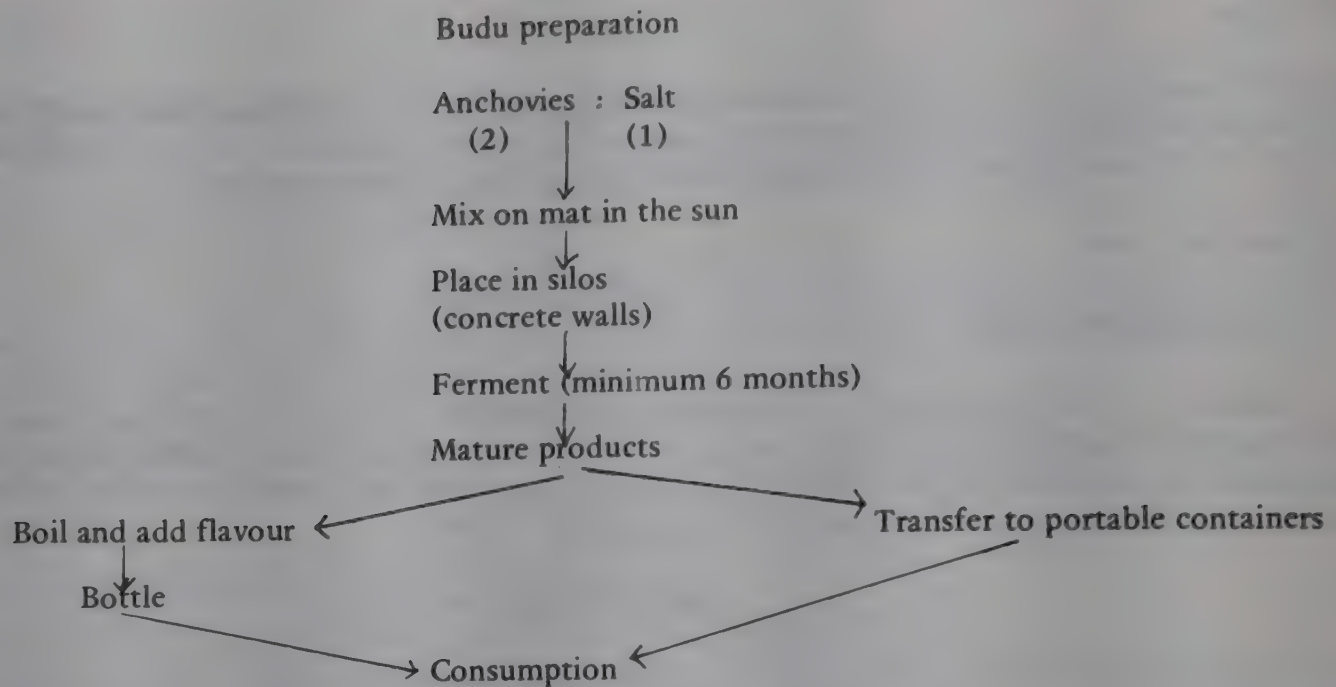
When properly cured, belacan should have a deep purple colour, a salty flavour and taste strongly of shrimp. Since the process is essentially one of microbial fermentation, it is possible that a method could be developed whereby a starter culture could be used as in other fermented food products such as cheese. Investigations should be carried out to develop cultures which could be used:

- (i) to make the product more uniform
- (ii) to reduce the salt content
- (iii) to speed up the process
- (iv) to make the process more hygienic

Packaging materials and methods should also be studied in order to develop a method of packaging which could make the product less affected by high humidity.

Budu (fish sauce)

Budu is another traditional product which is made in small quantities on the east coast. The raw material is anchovies (bilis) and the process is one of fermentation with salt. The traditional process is as shown in the following flow chart:



Although this product is of little significance at present in view of the small quantity produced, the materials used and the methods employed are similar in many respects to those used in southern Europe and Scandinavia (Sidaway and Balasingam, 1971). Similar products are widely produced and marketed in neighbouring countries; they are known by other names such as nampla in Thailand, nuoc nam in Vietnam, kicap ikan in Indonesia and patis in the Philippines (Beddows *et al.*, 1976). There is scope for improvement in the products and market potential in view of the fact that approximately 250 million people in ASEAN countries and Indochina consume fish sauce.

The following improvements could be looked into to produce better quality fermented products:

- (1) Control of fermentation to ensure uniform production of quality products, improved fermentation techniques and improved sanitation
- (2) Proper mixing facilities not only to increase efficiency but also uniformity of mixture
- (3) Stainless steel utensils for hygiene and good sanitary control
- (4) In terms of research and development, the type of organisms present, the nature of flavour active substances present in fish sauce, or in media inoculated with bacteria isolated at different stages of fermentation, and the possibility of using proteolytic enzymes, to increase the rate of fermentation, will have to be examined.

Other methods of curing

Pickling or conserving in vinegar and salt is again limited. Most of these products seen in the country are imported.

Canned products

Sidaway and Balasingam (1971) reported that the fish canning industry in Peninsular Malaysia was underdeveloped. There was only one tuna canning factory, in Penang, which also operated cold storage facilities for handling and processing other large fish such as marlin, shark and swordfish; yellowfin bigeye tuna and bonito were also canned. Today there are at least six factories processing more than 3 000 cans per day. The products are mainly chub mackerel (*Rastrelliger* spp.) and sardine (*Sardinella* spp.), usually in tomato sauce. The possibility of using local ingredients such as papaya, chilli sauce puree, refined and deodorized palm olein fractions has also been examined by the Utilization Division (APU) of the Malaysian Agricultural Research and Development Institute (MARDI).

Canning of other products such as cockles, anchovies and cuttlefish in local recipes is quite common. However, the scope for expansion is limited by local market demand considering the small urban population. The development of canned products for export would be necessary if the industry is to expand further.

The major problem encountered in the canning industry is the high cost of production, due mainly to the cost of the cans. Hence locally canned fish finds difficulty competing with Japanese imports. The supply of raw material, although erratic, is not considered to be a problem because the canning operation is sufficiently flexible to allow the product to be altered at short notice depending on the availability and price of raw materials.

The projected demand for canned fish up to 1955 (Fig. 3) indicates an increase of approximately 40 per cent between the years 1975 and 1995. The estimated fish canning potential (Fig. 4) shows that the number of factories could increase to 93, with an estimated investment of approximately M.\$ 465 million, in 1995. This projection is subject to the scale of development that could be undertaken by the Fisheries Development Board, the Fisheries Department of the Ministry of Agriculture, and the development of technology by agencies, e.g., MARDI, etc.

Fish reduction

The production of fish meal is a major activity; although fish oil is produced as a by-product, it is of little significance. Fertilizer is also produced as a by-product, but the bulk of the produce is used as a feed ingredient.

There are two types of processing in this country; one uses modern plant to cook, press and dry the fish, the other is a 'cottage' method in which fish are cooked and dried (Idrus *et al.*, 1977). However, there appears to be overcapacity within the country as none of the plants works to full capacity. Unless landings of trash fish (by-catch) increase markedly, no further licenses for fishmeal plants should be issued. The quality of much of the fishmeal produced is extremely low; protein contents as low as 40 percent were reported. There are two main reasons for this, firstly the raw material often includes crabs and other marine life which have a low protein content. Secondly, much of the by-catch which is brought to the processing plant has been left at ambient temperatures of 29°C and higher for several days. Such material is partially liquefied; much of the protein has drained away as fluid.

Work on silage has been reported by Yeoh *et al.* (1977) using the lactic acid fermentation method. The potential of this method, those of Gildberg and Raa (1977), using formic/propionic acid, and the TPI method using formic acid (Disney, 1977) is being evaluated by MARDI, for development and use in the country (Merican, personal communication, 1977).

QUALITY CONTROL

There is a need for improved quality control in the food processing industry. The organization of quality control is basically associated with the following sequence of operation (Pearson, 1973):

- (a) Agricultural control
- (b) Examination of raw materials, most of which have already been partially processed and submitted to some form of standardization
- (c) Formulation and examination of trial batches
- (d) Process control, which includes examination of 'intermediates', and checking and recording charts on equipment and hygiene inspection
- (e) Product examination including weight control and compliance with specifications and legal requirements
- (f) Storage controls in the warehouse and at retailers' premises.

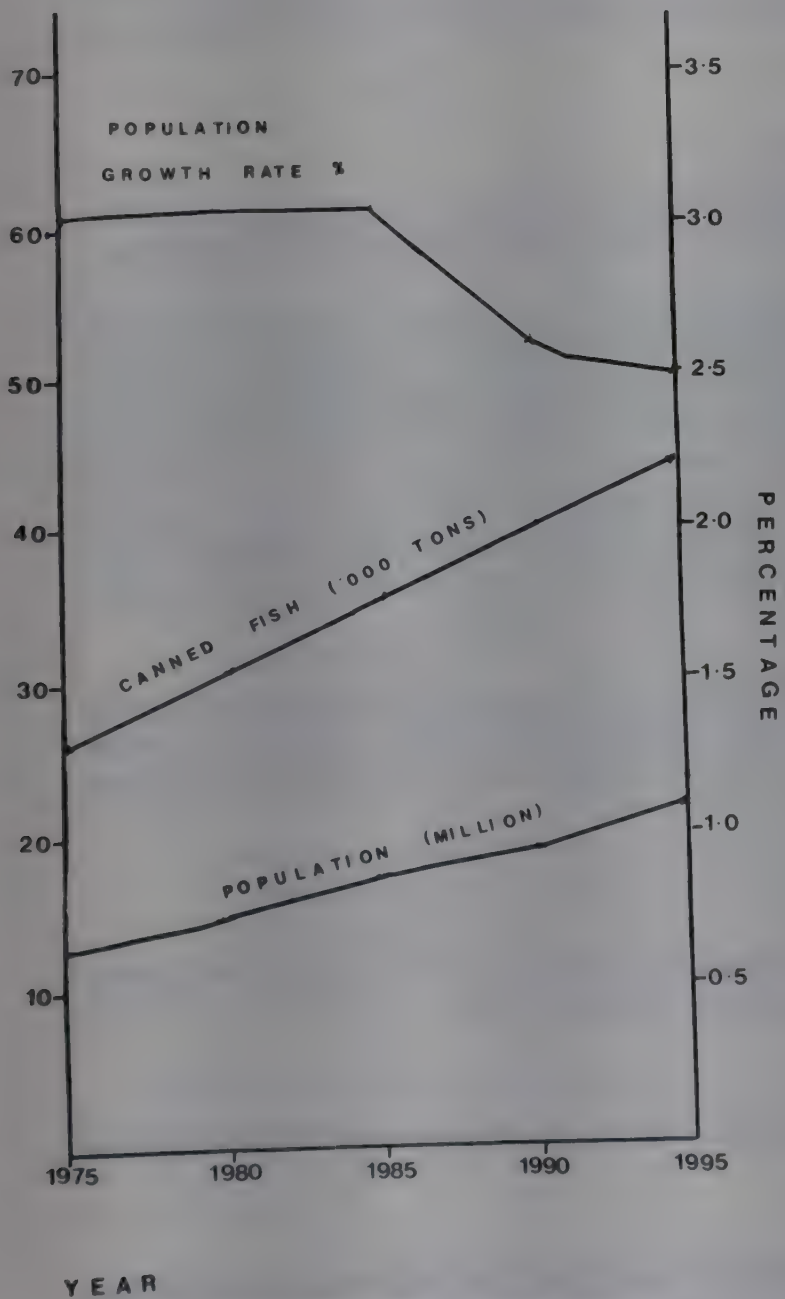


Fig. 3 - Population projection and canned fish demand in Malaysia (1975-95)

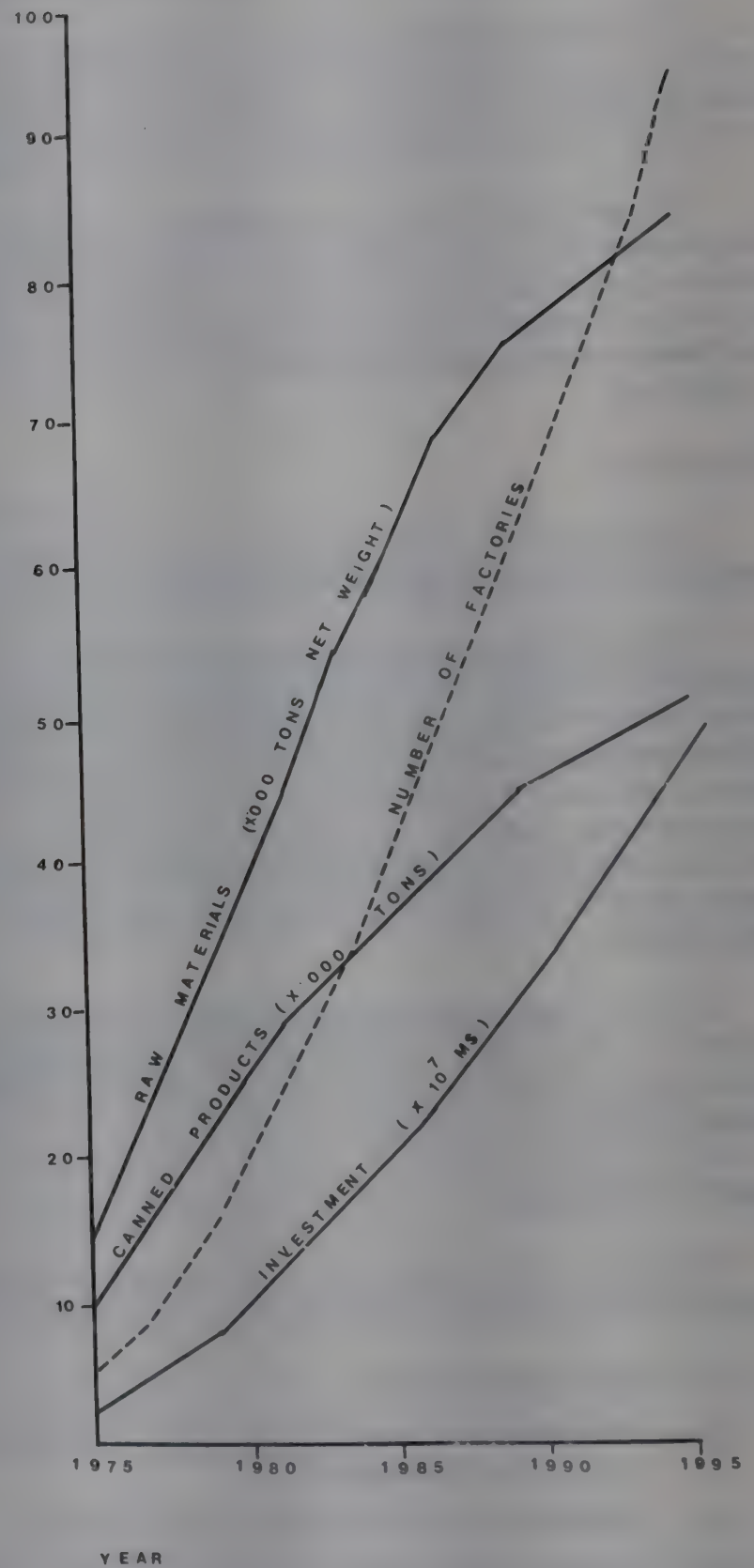


Fig. 4 - Estimated fish canning potential

"Quality can be considered as the product of various attributes, including composition and nutritional value, purity, appearance, taste, odour and consistency". (Pearson, 1973). If any of these attributes is low the general quality will be low. Commercially, however, variations from the norm are slight and quality is assessed by the summation of attributes.

Quality control implies a system that standardizes the materials used, the process itself and, subsequently, the product. The development of suitable rapid techniques, which may be indirect physical or empirical testing methods, is necessary. The objective of quality control is to ensure that the manufacture of products is standardized within appropriately selected commercial limits. Even though this is normally done to ensure that overweight and very high quality goods are not sent out, it equally ensures that the customer does not receive sub-standard products.

The Ministry of Health has formulated the code of practice for Hygiene and Sanitation of Food Premises which is being implemented. "This comprehensive code is designed to cover minimum standards for a wide range of food establishments ranging from eating places, manufacture, processing, preparations and sale to protect food during transportation, production storage, etc." (Merican *et al.*, 1977).

All processing plants are now required to be licensed either by the Ministry of Health or by the local authority depending on their location. There is an urgent need to enforce or implement these codes of practice, licensing laws and the Food and Drug ordinances effectively.

CONCLUSIONS

As the fish processing industry in Malaysia is of importance to the national economy, further improvements should be carried out in the supply sector of the fishing industry. Improvement in the techniques of handling on board ships needs to be emphasized. There is also a need to improve the availability of ice as well as to inform people about the importance of using ice to maintain the quality of fish. However, the use of ice may be influenced by the margin of profit. The provision of facilities such as refrigeration, insulated containers and freezers needs to be increased.

The preservation of fish from capture to preservation should be reviewed periodically and adapted to changes in the economy and technology.

The growth of the processing and fish utilization industry has increased the need for improved technology; consequently research and development are required in these areas. The establishment of the Food Technology Research and Development Centre (now in MARDI) has, since 1966, provided basic information and data on the state of the industry and technology. Further development in production has resulted from the increased activities of the MAJUIKAN (Fisheries Development Board) and other Government agencies. The need to supply the requirements of the industry by the Research and Development agencies is vital; it is also necessary for the industry to reciprocate the concern of the Government and its agencies when views are expressed over certain problems or difficulties within the industry. The effort in maintaining quality is tied up with good quality control and good manufacturing practices.

The industry as a whole, therefore, requires integrated development to cover various aspects of production, post-harvest handling and processing, quality control and market distribution.

REFERENCES

- Beddows, C.G., M. Ismail and K.H. Steinkraus, The use of bromelain in the hydrolysis of mackerel and the investigation of fermented fish aroma. *J. Food Technol.*, 11:379 p. 1976
- Cole, R.C., The Marine Fisheries Extension Services in Malaysia. Tropical Products Institute, London (unpublished report) 1977

- Disney, J.G., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In Proceedings of the conference on handling, processing and marketing of tropical fish*. Tropical Products Institute. London, 5-9 July 1976, pp. 231-40
- Gildberg, A. and J. Raa, Properties of propionic acid/formic acid preserved silage of cod viscera. *J.Sci.Food Agric.*, 24:647
- Idrus, A.Z. and M.I. Abdullah, Seminar on development of fisheries sector. Malaysian Economic Association, University of Malaya, Kuala Lumpur, Malaysia
- Kamari, A., A.Z. Idrus and Z. Merican, The handling and transportation of fish in Malaysia. *In Proceedings of the conference on handling, processing and marketing of tropical fish*. Tropical Products Institute. London, 5-9 July 1976, pp. 115-9
- Kreuzer, R. (Ed.), The technology of fish utilization. Fishing News (Books) Ltd., London
- Love, R.M., The expressible fluid of fish fillets. I. Nucleic acid as an index of cell damage in fillets frozen from both sides. *J.Sci.Food Agric.*, 6:30
- Malaysia, Ministry of Agriculture, Annual fisheries statistics
- 1968
- _____, Annual fisheries statistics
- 1976
- _____, Annual fisheries statistics
- 1977
- Malaysia, Ministry of Finance, Economic report, Kuala Lumpur
- 1977
- Merican, Z., A.Z. Idrus and A. Kamari, The frozen prawn industry in Malaysia. *In Proceedings of the conference on handling, processing and marketing of tropical fish*. Tropical Products Institute, London, 5-9 July 1976, pp. 399-404
- Pearson, D., Laboratory techniques in food analysis. Butterworth and Co., London, 565 p.
- 1973
- Sidaway, E.P. and M. Balasingam, Fish processing industry in Malaysia (Technical study) Food Technology Research and Development Centre, Ministry of Agriculture, Malaysia
- 1971
- Sivalingam, P.M., Seminar on development of fisheries sector, Malaysian Economic Association, University of Malaya, Kuala Lumpur, Malaysia
- 1971
- Wahby, O., C.G. Erikson and A. Sabri, Fish processing industry in Malaysia (Economic survey), Food Technology Research and Development Centre, Ministry of Agriculture, Malaysia
- 1970
- Yeoh, Q.L., W.R. Stanton and T.K. Murkerjee, Production of fish silage for animal feed. Symposium on feed-stuffs for livestock. Malaysian Society of Animal Production and MARDI. National University of Malaysia, Kuala Lumpur, Malaysia
- 1977

FISHMEAL PROCESSING: STATUS AND PROSPECTS IN MALAYSIA

by

Ahmad Zahrudin Idrus, Wan Rahimah and Jainudin Abdullah
MARDI, Serdang
Selangor, Malaysia

Abstract

Fishmeal is an important animal feed ingredient particularly in the pig and poultry feed industry. It is processed mainly from trash fish although offal and trimmings from the fish processing industry may be used. The demand for fish meal is presented and the prospect for future development is examined in relation to the volume of trash fish available as well as the possible increase in by-products from the fish processing industry.

The local method of fishmeal production is examined. The nutrient value of fishmeal from local methods of preparation and that from the standard methods is presented.

INTRODUCTION

Fishmeal is produced by the following operations: cooking, pressing, drying and grinding. There are two major sources of raw materials, namely, by-catch (which amounted to 31 percent of 1976 marine fish landings) and offal and trimmings from fish canning factories. It is used as an ingredient in animal feed mixes for the feeding of pigs, poultry, oxen and for sheep and goats during stall feeding.

Cottage processors in Malaysia produce fishmeal of lower quality than from established plants and it is not readily accepted by animal feed millers in the country. Inferior grade fishmeal produced by cottage methods, such as sun-drying, is in the form of unground scraps and is often contaminated with sand and clay; it is sold as fertilizer. However, the use of fish as a fertilizer is on the decline with the introduction of synthetic fertilizers and with the increase in the price of fish in the market.

FISHMEAL INDUSTRY IN MALAYSIA

The growth of the fishmeal industry can be attributed to two major factors, namely the rapid development of the local animal feed industry and the introduction of trawl fishing.

There has been an accelerated development of the animal feed industry since 1960. In early 1973, there were only 11 feedmills operating in Peninsular Malaysia but by July 1977 this figure had risen to 23 (Monthly Industrial Statistics, 1973-77). The production of mixed poultry and pigs feeds also dramatically increased from 1971 (216 182 tonnes) to 1976 (389 789 tonnes). During the first half of 1977 alone a total of 228 736 tonnes of feed for poultry and pigs were compounded.

Fishmeal is an important ingredient in the formulation of balanced diets for livestock because of its high protein content. The amount used in animal feed formulation is 2-15 percent depending on the type of ration required. Fishmeal can be substituted by other ingredients such as meat and bone-meal and soybean meal.

Chicken and pork are important in the diet of more than half the population of the country. These two sectors of the livestock industry are the most commercialized with average annual growth rates of 12 percent for poultry and 10 for pigs between 1970 and 1975 (Economic Report 1977-78). This trend is expected to continue.

According to a livestock census in 1976 there were 1,308 265 pigs and 15 757 573^{1/} poultry in Peninsular Malaysia. Based on these figures and growth rates, the projected populations of pigs and poultry for the year 1985 are 3 084 820 and 43 696 161 respectively. The projected demands for poultry, eggs and pork are shown in Table 1. Since pigs and poultry are the major consumers of fishmeal there should be a parallel growth in fishmeal production.

Table 1

Projected demand for poultry, eggs and pork^{a/}
(t x 10³)

Year	Poultry	Eggs	Pork
1978	105.3	957.2	68 492.2
1979	114.1	1 023.2	71 040.1
1980	123.6	1 093.8	73 682.8
1981	133.9	1 169.3	76 423.8
1982	145.0	1 250.0	79 267.0
1983	157.0	1 336.2	82 215.8
1984	170.0	1 428.4	85 274.0
1985	184.2	1 526.9	88 446.4

a/ Source: Veterinary Department Statistics 1972-76

Trawl fishing has expanded since it was introduced in 1963 in West Malaysia. This can be seen in the number of licenses issued by the Fishery Division (horsepowers from 10-60). In the east coast of West Malaysia separate licenses for lower-powered trawlers are issued for monsoon periods. The percentage of by-catch in West Malaysia has increased considerably over the years; from 19 percent (56 506 tonnes) to 31 percent (127 481 tonnes) of total marine fish landings from 1970-76 (Table 2). Landings figures for the years 1972-76 show that 50-60 percent of the by-catch in West Malaysia was obtained from trawl landings (Annual Fisheries Statistics, 1970-76.)

The increase in by-catch with the introduction of trawling activities led to rapid increase in the number of fishmeal plants. In 1964 there was only one plant with an annual production of 29.4 tonnes (Loh, 1973). However, this number increased to 31 in 1973 (Table 3) with a total production capacity of 84.2 tonnes of fishmeal per day. It can also be seen that production is concentrated in the west coast of Peninsular Malaysia, that is, in the states of Selangor, Johore, Kedah and Penang. It should be noted that the total number of fishmeal plants does not include many of the small unlicensed plants which can contribute quite significantly to the total fishmeal production in the country.

1/ Figures for the states of Kedah, Perlis and the Federal Territory are not available

Table 2

By-catch landing by States, 1970-76 (t)^{a/}

States	1970	1971	1972	1973	1974	1975	1976
Perlis	60	62	99	2 058	2 783	3 118	2 944
Kedah	4 954	7 814	12 409	16 658	16 790	18 468	17 590
Penang	10 084	11 274	10 761	10 364	7 785	4 851	3 884
Perak	14 634	15 900	14 386	17 001	29 097	22 620	27 930
Selangor	10 792	19 943	26 535	46 025	58 608	50 573	44 638
Negri Sembilan	—	—	—	—	—	—	—
Malacca	247	227	61	86	94	98	88
Johore	12 998	17 980	13 321	15 573	15 952	132 55	15 113
Kelantan	187	83	227	405	490	667	491
Trengganu	364	614	729	2 209	6 505	6 981	8 380
Pahang	1 204	1 290	1 880	3 521	8 521	4 556	6 423
Total by-catch landing	56 506	75 166	80 381	113 909	146 567	125 185	127 481
Total marine fish landing	299 005	323 061	311 108	371 230	439 575	373 235	410 968

a/ Source: Annual Fisheries Statistics 1970-76

Table 3

Fishmeal plants in Malaysia, 1973^{a/}

State	Number of plants	Capacity ^{b/} (t/day)	Raw material	
			(t/day)	(t/year)
Kedah	4	1.5	7.5	1 500
Penang	4	18.5	92.5	17 500
Perak	1	4.0	20.0	4 000
Selangor	13	28.3	141.5	28 300
Pahang	1	13.8	65.0	13 000
Johore	7	16.9	84.5	16 900
Sabah	1	2.0	10.0	2 000
Total	31	84.2	421.0	83 250

a/ Source: Fisheries Division, Ministry of Agriculture

b/ Assumption: 200 factory days per year and 200 fishing days per year

There is a very wide variation in the daily production capacities of these small-scale (less than 2.5 tonnes) medium-scale (from 2.5 to less than 5 tonnes) and large-scale plants (5 tonnes and above). The large-scale plants use the machine-drying process while the small-scale plants use sun-drying or kiln-drying processes.

In general, simple processes are used and there are only a few modern plants available that are capable of handling 20-25 tonnes wet fish per day. Many fishmeal plants also operate below full-production capacity. This is mainly due to the irregular supply of raw materials. During monsoon periods many of the plants operate at 50 percent capacity or lower. The by-catch may be available in scattered areas; this leads to the uneconomic operation of larger plants. In addition to these problems there are many in-shore vessels which catch fish mixed with various crustaceans and mollusks; this yields fishmeal of low quality with a high ash and low protein content.

Since there is an ample supply of raw material, the country should aim at self-sufficiency in fishmeal. The net import of fishmeal, however, increased for the years 1965-68; the bulk of the imports were from Thailand and China. Malaysia also imports fishmeal from Japan, Pakistan, Peru, Chile and other African countries in lesser quantities. With the imposition of the 75 percent import quota in 1968 and the increased local production (as shown in Table 4) the import of fishmeal has gradually decreased (Table 5). However, in 1976 Malaysia imported about 5 000 tonnes of fishmeal at a cost of around U.S.\$ 5 million; only 7 700 tonnes were produced.

Table 4

Fishmeal production in West Malaysia, 1970-76 (t)^{a/}

Year	Weight of Fish processed ^{b/}	Fishmeal production
1970	44 139	8 286
1971	41 094	6 417
1972	44 417	5 330
1973	55 609	6 306
1974	54 494	14 108
1975	45 632	12 203
1976	38 476	7 707

a/ Source: Annual Fisheries Statistics 1970-76

b/ Other processed products include the following salted or dried fish, boiled fish, smoked tuna, dried anchovies, dried prawns, cooked frozen prawns, fish and prawn crackers, fish used as manure and fermented products such as budu (pickled anchovies) belacan (shrimp paste) and cencalok (fermented shrimp products)

Table 5

Import and export of fishmeal for West Malaysia, 1968-76 (t)^{a/}

Year	Import		Export		Net import (t)
	(t)	(M.\$)	(t)	(M.\$)	
1968	13 568	5 296 018	922	218 600	12 646
1969	11 436	4 983 620	1 497	439 358	9 939
1970	11 374	5 108 282	2 663	846 400	8 711
1971	9 455	4 118 359	3 553	11 460 000	5 909
1972	10 077	4 663 600	4 893	1 695 800	5 184
1973	4 222	2 234 900	14 359	7 312 700	— 10 137
1974	3 752	2 597 500	8 585	3 968 400	— 4 833
1975	9 905	5 988 571	3 387	1 260 961	6 518
1976	8 914	5 431 977	4 202	1 337 580	4 712

^{a/} Source: Ministry of Agriculture 1968-76*Development Projections*

The objective of the Malaysian Fishery Development Programme is to increase the total catch from 410 000 tonnes in 1976 to 900 000 tonnes in 1995 to meet the demands for human consumption and for feeding live-stock from the projected catch, shown in Table 6, and using the projections in Table 1, the demand for fishmeal, therefore, has to keep pace with the increase in demand for poultry, eggs and pork. A growth in demand of 5 percent per year is estimated. The projected fishmeal production for 1995 is 54 000 tonnes (Table 6).

Table 6

Fishmeal production/export projections according to projected catch (t)^{a/}

ALTERNATIVE I

Year	Projected catch	Projected by-catch	Projected production	Projected demand	Projected export
1980	550 000	165 000	33 000	14 500	18 500
1985	680 000	204 000	40 800	16 700	24 100
1990	790 000	237 000	47 400	19 000	28 400
1995	900 000	270 000	54 000	21 400	32 600

ALTERNATIVE II

Year	Projected catch	Projected by-catch	Projected production	Projected demand	Projected export
1980	520 000	156 000	31 200	14 500	16 700
1985	640 000	192 000	38 400	16 700	21 700
1990	770 000	231 000	46 200	19 000	27 200
1995	900 000	270 000	54 000	21 400	32 600

a/ Source: Labon, 1974

From the total catch of 410 000 tonnes in 1976, a total of 127 481 tonnes of by-catch was available for fishmeal production (Table 2). Using the conversion ratio of 5:1 by-catch to fishmeal, a total of 25 496 tonnes of fishmeal could have been produced if all the by-catch had been directed toward fishmeal production. Theoretically this figure ought to be sufficient to meet the estimated demand of 12 000 tonnes for that year. However, many of the existing fishmeal plants use crude traditional methods of processing (sun-drying followed by coarse grinding) and the country needs to import high quality fishmeal.

If all of the projected by-catch of 270 000 tonnes for 1995 were to be directed toward the production of high quality fishmeal there would be an excess of 32 600 tonnes of fishmeal available for export (Table 6). At the current wholesale price of M.\$ 670^{1/} per tonne, a total revenue of M.\$ 22 million could be obtained. Based on 200 working days (200 fishing days) a year, the total capacity of fishmeal factories required to cope with the anticipated production of 54 000 tonnes in 1995 is estimated to be 270 tonnes of fishmeal per day. This requires an additional capacity of 185.8 tonnes per day over the 1973 total capacity (Table 7).

Table 7

Requirement of additional fishmeal capacity^{a/}

ALTERNATIVE I

Year	Projected fishmeal production (t)	Factory capacity ^{b/} (t/day)	Additional capacity required (t/day)
1980	33 000	165.0	80.8
1985	40 800	204.0	119.8
1990	47 400	237.0	152.8
1995	54 000	270.0	185.8

ALTERNATIVE II

Year	Projected fishmeal production (t)	Factory capacity ^{a/} (t/day)	Additional capacity required (t/day)
1980	31 200	156.0	71.8
1985	38 400	192.0	107.8
1990	46 200	231.0	146.8
1995	54 000	270.0	185.8

a/ Source: Fisheries Division, Ministry of Agriculture

b/ 200 working days/year

Raw Materials

Present output is not influenced by the production capacity of the plants but by the availability of raw materials. The raw material may be by-catch and fish waste from fish canning operations. Some establishments make use of small species of fish suitable for human consumption such as the local herring-like tamban (*Clupea* spp.) selar kuning (*Selaroides leptolepis*) and selayang (*Decapterus russelli*) especially during times of glut.

By-Catch

By-catch may consists of fish, crustaceans, mollusks, etc., and the proportion of these will largely determine the quality of the fishmeal produced. Every sample of by-catch differs in the proportion of fish types which also varies with the season and the place of haul. The value of the by-catch depends on several factors such as season, fishing ground, distance from factory to landing place, coast of labour, cost of transport, etc. The price has decreased with the introduction of trawling. At present the cost of by-catch is between M.\$ 40-75 per tonne in the east coast while on the west coast it is about M.\$ 127 per tonne. The conversion rate from by-catch varies from 16 to 40 percent depending on the method of processing, the average being 20 percent.

Offal and trimmings from the fish processing industry

Fish waste from canneries and smoked fish industries can supplement the by-catch as the raw material for the production of fishmeal. At the moment there are not many fish canning plants and only 2 percent of the total catch was channelled into canning during the years 1966-71. However, with the projected catch of 900 000 tonnes in 1995, the number of canning plants may increase; offal and trimmings from such plants will undoubtedly become an important source of raw materials for fish meal. An estimated 12 000 tonnes canned products will be produced by 1995 (Labon, 1974).

Waste material from the canning industry is in two forms: heads, tails and guts, prior to steaming, account for 35 percent (sold at about M.\$ 70 per tonne); and red meats and bones. After steaming, account for 25 percent of the waste (sold at about M.\$ 90 per tonne). The recovery of flesh from tuna and sardine canning is 40 and 65 percent respectively. It is observed that the conversion rate of fish canning waste to meal is higher than that from by-catch, being in the order of around 40 percent. The quality of the fish meal produced is also better; it has a higher protein and lower ash content as shown in Table 8 (Wan Rahimah, 1975, unpublished).

Table 8

Comparison of fishmeals produced from by-catch and from cannery waste^{a/}

%	By-catch	Tuna offal
Moisture content	10.78	9.64
Protein	56.32	67.90
Fat	4.25	9.69
NaCl	3.46	0.72
Acid insoluble ash	2.72	0.18
Ash	28.65	12.77

a/ Source: Wan Rahimah, 1975, unpublished

Fishmeal Processing

Methods of fishmeal production in Peninsular Malaysia can be divided into two categories, namely, the traditional (backyard) method involving sun-drying, and the modern machine processing method. The conversion rate is dependent on several factors, e.g., the processing method, type of raw material used, size of fish and efficiency of the processing unit.

The main steps in the preparation of fishmeal are cooking, pressing the cooked slurry, drying the pressed cake and grinding it into fishmeal. Cooking facilitates the coagulation of the protein to a point where it can be successfully pressed and this process also frees the water that is chemically bound. Over-cooking will result in a soft and mushy texture which does not permit ready straining of the liquor; under-cooking will render the fish hard to press and excess moisture and oil will not be released. The cooked fish is then pressed in a single or double-screw press to facilitate the removal of oil (to about 4 percent) and to reduce the moisture content from 70 percent to about 50 percent. The press cake is then dried in a long, cylindrical, slowly rotating drum. Insufficient drying will allow the growth of moulds and bacteria; an over-dried product will result in scorching with reduced nutritional value. The product is collected in heaps on the floor, milled and then bagged for sale.

Traditional methods of fishmeal processing are inexpensive and simple and are limited to low-capacity production. Low quality fishmeal with a low protein and high ash content, and high bacterial load, is produced. A survey of traditional methods in the state of Trengganu (Wan Rahimah, 1975 unpublished) showed that a variety of methods were used by the fishmeal producers. Often the by-catch is boiled for 10 min to 2 1/2 h, pressed, roasted or fried for 3-7 h prior to grinding, sieved and packed. Another method involves the direct frying of fish, for 3-15 h, depending on the establishment, which are then left to dry in the shade. The fish are fried in pans of about 4 ft diam and stirred mechanically. The two sources of fuel are kerosene and firewood (M.\$ 4 to dry one tonne of by-catch). Sometimes the backyard processing also involves the addition of salt, before or after boiling the fish, followed by sun-drying. This contributes to a high salt content in the fish meal (samples KT₃ and KT₄ in Table 9).

Table 9

Analysis of fishmeal produced by traditional methods^{a/}

Sample	Moisture content	Protein	Fat	Ash	NaCl	Acid insoluble ash
KB ₁	10.85	54.44	5.57	25.13	2.36	3.79
KT ₁	11.57	55.43	5.80	27.20	3.94	3.55
KT ₂ *	22.21	51.49	6.16	20.14	10.96	0.16
KT ₃ *	33.06	32.23	5.11	29.60	21.07	0.24
KT						
KT ₄ *	34.97	29.33	7.73	27.97	20.75	0.15
KT ₅	12.12	53.77	3.88	30.23	3.25	4.47
M ₁	6.26	59.42	5.65	26.39	2.27	3.34
M ₂	11.22	56.34	7.73	24.70	0.85	0.21
M ₃	15.39	60.20	3.35	21.05	3.28	2.75

a/ Source: Wan Rahimah, 1975, unpublished

* Sampled as dried fish scraps

Two forms of fishmeal are on sale in Malaysia, finely ground products which account for about 80-90 percent of production, and fishmeal sold as dried fish scraps, which is usually ground by secondary processors.

Quality of Fishmeal

The quality of fishmeal is determined mainly by its protein content. Fishmeal produced by modern processing techniques contains a higher percentage of protein than that of backyard industries. Fishmeal produced by backyard plants is often inconsistent in quality (Table 9). Table 10 gives the standard requirements in Malaysia for fishmeal as an animal feedstuff. It can be seen from Table 11 that even the large licensed plants do not produce fishmeal that conforms to the standard requirements.

Table 10

SIM requirements for fishmeal as animal feedstuff^{a/}

Item No. ^{b/}	Property (% by weight)	Requirement
(i)	Moisture (max)	12
(ii)	Crude Protein (min)	55
(iii)	Crude Fat (max)	10
(iv)	Sodium chloride (max)	3
(v)	Acid insoluble ash (max)	2

a/ Source: Standards Institution of Malaysia (SIM) 1974

b/ Requirements for items (ii) to (v) are on moisture-free basis

Table 11

Analysis of fishmeal produced by modern methods

Sample	Moisture content	Protein	Fat	Ash	NaCl	Acid insoluble ash
J ₁		42.09	6.67	33.39	0.62	1.76
J ₂	11.58	43.98	4.29	36.43	0.60	3.22
J ₃	7.75	43.60	4.03	26.67	0.48	1.94
J ₄	9.38	46.69	11.00	29.40	0.43	4.66

Fishmeal is said to be of high quality if its protein content is 60 percent or more. There is an inverse relationship between protein and ash content. A high ash content indicates that large quantities of fish bones and shells of crustaceans and mollusks were present in the raw material. The moisture content should be about 10 percent. A sample containing more than 12 percent moisture is more prone to mould growth whereas one containing less than 5 percent predisposes the fishmeal to the risk of overheating from oil oxidation during storage.

The fat content should be in the range of 5-10 percent; if the fat content is lower, the fishmeal will be dusty, if higher, the fishmeal is prone to rancidity. Fishmeal with high acid insoluble ash indicates that the sample was not prepared hygienically or that the product has been adulterated to give bulk.

Local fishmeal processors are facing strong competition from the imported products; the feedmillers seem to prefer the imported fishmeal from Thailand even though its protein content is roughly identical to that of local products. This preference for imported fishmeal can be attributed to prejudice against the local fishmeal and the more consistent quality of the imported product. The protein of imported fishmeal is given in Table 12.

Table 12

Protein content of imported fishmeals^{a/}

Country	Protein content (percent)
China	60 – 65
Thailand	55 – 60 61 – 65
Chile	60 – 65 66 – 68
Japan	60 – 65 66 – 68
Peru	60 – 65 66 – 68

a/ Source: Federal Industrial Development
Authority (FIDA), 1974

CONCLUSIONS

There is an immense potential for the fishmeal industry in Malaysia in view of the anticipated increase in the supply of by-catch when the fishery harbours, complexes and fishing villages are established under the Fisheries Development Programme. An increase in demand for fishmeal is also expected with the growth of the live-stock industry in the country.

The present fishmeal industry is rather simple in nature. There are numerous small fishmeal plants scattered in various parts of the country and most of these are of the cottage type producing crude forms of fishmeal of low quality. Due to the inconsistent quality of their product, the local feedmillers tend to prefer imported fish meals. Small backyard operations should be discouraged; this should pave the way for the development of larger plants, producing high quality fishmeal, to meet the increasing demand for fishmeal.

In conclusion, the following recommendations need to be considered to ensure the viability of fishmeal processing industry:

- (1) More strict supervision of trawling activities. With the increased demand for by-catch, the trawler operators may resort to illegal catching of the fry of commercial varieties.
- (2) The quality of local fishmeal should be consistent and conform to the standard requirements.
- (3) To encourage local feedmillers to utilize local fishmeal.
- (4) Before approving licenses for new fishmeal plants, the licensing authorities should ensure that the existing factories are operating at their maximum capacity. In the setting-up of new fishmeal plants the following factors should be considered:
 - availability of raw materials;
 - proximity to jetty to minimize transport costs;
 - pollution problem in relation to discharge of waste.

REFERENCES

- Labon, A., Malaysian long-term fisheries development plan until 1995. FAO, Rome, p. 8
1974
- Loh, W.K., The fish meal industry in Peninsular Malaysia. Federal Agricultural Marketing Authority (FAMA),
1973 Malaysia. Bulletin No. 4, 6-10
- Malaysia, Department of Statistics, Monthly industrial statistics, Peninsular Malaysia
1973-1977
- Malaysia, Federal Industrial Development Authority, A feasibility study on fishmeal
1974
- Malaysia, Ministry of Agriculture, Import and export trade in food and agricultural products, West Malaysia
1968-76
- _____, Annual fisheries statistics
1970-76
- _____, Veterinary department statistics
1972-76
- Malaysia, Ministry of Finance, Economic report
1977-78
- Standards Institution of Malaysia, A feasibility study on fishmeal
1974

FISH PROCESSING INDUSTRY IN INDIA

by

K.K.P. Menon

The Tata Oil Mills Company Ltd. (Fisheries Division)
Cochin, India*Abstract*

Since independence the fish processing industry has adopted modern technology and is catering to the needs of sophisticated markets abroad. The export trade has played an important role in the development of the industry. The export of marine products has increased from 17 297 tonnes in 1961, valued at I.Rs. 41 million^{1/}, to 62 151 tonnes, valued at I.Rs. 1 798 million in 1976. The phenomenal growth of the industry has been achieved through research work carried out in technological laboratories and institutions.

All fish and fishery products exported from India are now subject to compulsory quality control and pre-shipment inspection. A scheme for voluntary inspection of export consignments was set up in 1963. The Government of India introduced compulsory quality control for fish and fishery products in 1965. To ensure very strict quality standards of fishery products, a continuous in-process inspection scheme is also being introduced. Statutory technical standards for fishing vessels, pre-processing centres, processing plants, packing centres, storage premises and conveyances are specified.

INTRODUCTION

The fish processing industry in India has grown considerably during the last quarter of a century. During 1976-77, the export of marine products from India earned I.Rs. 1 891 million, representing 0.7 percent of the world trade in fishery products and 3.7 percent of the export earnings of the country, ranking eighth in the order of export-earning commodities of India.

India has a long history of trade in traditionally dried or cured fish and fishery products. Fishing and allied industries in colonial India were probably the least developed of her industries. Dry prawn pulp, cured and pickled fish maws, etc., were the important commodities exported to neighbouring countries. These countries imposed an almost total ban on imports of our fishery products after the second world war, causing unemployment for thousands of fishermen and fish merchants. There was no demand for these traditional products in western markets. Because modern techniques like freezing and canning were almost unknown, large quantities of fish were converted to manure. It is against this background that one has to assess the present status of the fish processing industry in India.

DISPOSITION OF THE CATCH

Before 1950, 42.7 percent of the total fish production was consumed fresh, 25.9 percent was sun-dried, 24.8 percent was converted into salt cured fish and 6.6 percent was reduced to fish manure. Over the past few years the disposition of the catch has changed considerably as shown in Table 1.

During the last one and a half decades, fresh, frozen and canned fish have gained importance, whereas the quantity of fish used for traditional curing has reduced considerably.

1/ I.Rs. 1 = U.S.\$ 0.119 (April 1978)

Since independence the fish processing industry has developed from traditional drying and salting to cater for the needs of the sophisticated export markets through the adoption of modern technology. In the early stages of this development India depended on foreign technological knowledge as little development work had been undertaken in the cononial era. Today, India is well advanced in the field of fish processing and the export trade has played a vital role in this development. The fish processing industry is often referred to as an export business because their development was simultaneous.

Table 1

Disposition of the catch in India

Utilization category	Percentage disposition					
	1961	1971	1972	1973	1974	1975
Fresh	47.9	66.0	68.2	65.3	63.7	69.6
Freezing	—	5.3	5.0	5.4	4.5	2.8
Curing	43.7	19.3	17.5	19.4	23.2	18.9
Canning	—	0.7	0.7	0.8	0.4	0.2
Reduction	8.4	5.6	4.9	5.2	4.3	6.0
Miscellaneous purposes	—	2.9	3.2	3.8	3.2	1.9
Offal for reduction	—	0.2	0.5	0.1	0.7	0.6

EXPORT OF MARINE PRODUCTS

In 1953, a small quantity (13 268 kg) of frozen shrimp valued at I.Rs. 57 740 was exported to the U.S.A. This was a turning point in India's fish processing industry. The product was well accepted and paved the way for the present billion dollar business (Table 2).

Table 2

Export of marine products

Year	Quantity (tonnes)	Value (I.Rs. thousands)
1957	22 778	45 861
1967	21 764	199 286
1968	24 810	220 846
1969	30 584	330 731
1970	37 175	355 359
1971	34 032	391 725
1972	38 271	581 317
1973	48 785	795 763
1974	46 629	763 127
1975	53 412	1 049 063
1976	62 151	1 798 620

In 1976, exports reached an all-time record, representing a growth of more than 16 percent in quantity and 71 percent in value over the previous year. The change in export pattern from traditional products to more sophisticated processed fishery products is noteworthy. Whereas 84 percent previously cured products accounted for 96 percent in value, now the same amount is exported as frozen products.

Major items of export

India exports about 37 marine products of which frozen shrimp alone accounted for 77.15 percent in terms of quantity and 89.34 percent in terms of value in 1976. The following are the other major items exported:

Frozen products:	Froglegs, lobster tails, cuttlefish, squids, fish, crab meat
Canned products:	Shrimp, crab meat, mussels, sardine, mackerel, tuna, other fish, clams
other items:	Dried shrimp, dried fish, shark fins, fish maws, beche-de-mer, turtle meat

Major markets

India exports fish and fishery products to nearly 60 countries. During 1976, export to Japan and the U.S.A. jointly accounted for 79 percent in terms of quantity and 91 percent in terms of value. Japan bought 45 percent in terms of quantity and 65 percent in terms of value and the U.S.A. 34 percent in terms of quantity and 26 percent in terms of value. Other important markets are Australia, France, the Federal Republic of Germany, Belgium and Sri Lanka.

LEVEL OF TECHNOLOGY IN THE FISH PROCESSING INDUSTRY

The progress which has been made in fish processing during the past two decades is mainly due to the technological research carried out in various laboratories. The establishment of the Central Institute of Fisheries Technology in 1957 was a milestone in the development of fishery technology and industry. The development of indigenous know-how in all aspects of fish processing technology by the Institute has resulted in the present enviable status of the industry.

The most advanced fish processing industry in India is that of freezing. The shrimp freezing industry is a typical example of how modern technology can be applied. Contact plate freezers, imported or locally made are, operated in most freezing plants.

Frozen prawns suffer weight loss during thawing and the processor adds an extra weight of prawns in order to make up for this loss. Considering the volume of trade in frozen prawn, the loss of material sustained by the industry and the consequent loss of foreign exchange to the nation are of a very high magnitude. This problem was studied in detail and a successful method of treating peeled prawns with a solution of sodium tripolyphosphate and potassium dihydrogen phosphate was developed; the drip loss could be completely prevented thereby increasing the yield by 10 percent. Further advantages noticed were: size grade remains unchanged; improved appearance and flavour of the product, and low cost of treatment compared to the gains. This method was adopted by the industry until recently; some buyers objected to the use of such chemicals in frozen shrimp and this treatment was stopped. Effective steps have to be taken to persuade the buyers to accept the frozen shrimp treated with such chemicals, so that at least 10 percent saving of raw material can be obtained.

A problem with peeled, deveined and cooked frozen prawns is excessive losses during cooking which amount to 45 percent. This can now be reduced to 10-15 percent by pre-treatment with the phosphate solution containing 16 percent common salt.

Development of black spot in whole and headless prawns during ice storage and in frozen storage was also a problem. A simple dip treatment or glazing with sodium metabisulphite solution can prevent this.

A method has been found to prevent the belly of oil sardine from bursting during freezing and frozen storage; the fish is pretreated with a 15 percent solution of sodium chloride.

Methods of freezing prawns in different forms, e.g. headless, peeled and deveined, peeled and undeveined, cooked and peeled; other shellfish, e.g. clams, mussels, crab meat; and fish; e.g. sardine, mackerel, pomfrets, seer, *Lactarius*, etc., have been worked out. These methods are being adopted by the industry for export and internal marketing.

The frozen frogleg industry has also received attention from the technologists. A method for the painless removal of legs from live frogs has been developed and techniques have been perfected for hygienic freezing. The product is almost free from the pathogenic organisms *Salmonella*.

One of the earliest problems faced by the prawn canning industry was the irregularity in the drained weight; this was solved by standardizing the blanching conditions. Prawns canned in brine showed blackening at the cut ends, which made them unsuitable for export. This was due to the presence of copper and iron which are converted to their sulphides during processing. In the case of marine prawns it could be prevented by maintaining the titratable acidity above 0.6 percent (as citric acid) in the brine. In brackishwater prawns, the addition of 50 mg percent of ethylene diamine tetra acetic acid (disodium salt) in the brine completely prevented blackening and improved the colour.

Local varieties of fish were not canned until the 1960s. Now standard methods have been developed for canning fish and shellfish like seer, sardine, mackerel, clam, mussel, crab, etc., in different media such as brine, oil and tomato sauce. The method for canning sardine in its own juice deserves special mention. This natural pack dispenses with the costly oil, retains the natural taste and flavour of the fish; it is hoped that canning of the sardine will become a major industry in the future.

Sun-drying is probably the cheapest and oldest method of preserving fish but the dried fish were unhygienic with a poor storage life. This traditional industry has now been improved by the use of artificial driers. Traditional curing methods, practised along the coast, have also been improved. Wet curing, dry curing, pit curing, Colombo curing, etc., gave unattractive and unhygienic products with very poor storage life. This industry is of great economic importance to the coastal fishermen and methods have been worked out by which cured products of improved appearance, organoleptic properties and storage life can be prepared. When a mixture of 3 percent sodium propionate in refined salt (1 part) is added to 10 parts of fish, spoilage due to fungal growth, red halophilic bacteria and humidity is prevented and the storage life of cured products is increased to 9-12 months.

Considerable progress has been made in the utilization of the waste material from the prawn and fish processing industry, and of fish which do not find ready market. Chitosan has been prepared from the shell and head of prawns; it can be used in sizing of textiles, water and wine clarification, as a base for chromatography, etc. A liquid fertilizer suitable for the common crops has been prepared from prawn and fish waste by a method of digestion with acid and subsequent neutralization with alkali. A method is now available for the preparation from "trash fish" of bacteriological peptone, which is comparable with the imported product. There is a traditional trade in sardine oil on the Malabar coast. The oil, extracted by crude methods, was used mainly for painting country crafts. If the oil is extracted scientifically, it can be used like vegetable oils for industrial purposes, especially in the preparation of antifouling paints and printing ink.

Though the fish processing industry is mainly export-oriented, some progress has been made in internal marketing. Frozen fish products are now sold in India; this is mainly due to improvements in socio-economic conditions, but also because consumer resistance to frozen fish is vanishing. However, the investment required for the transportation and storage of frozen fish hinders development of the fish freezing industry for the domestic market. Modern equipment for processing fish as fillets, slices and other forms was not available until recently. The freezing plants use plate freezers to process shrimp; only a few plants have tunnel freezers to process whole fish. This has all contributed to the slow growth of the frozen fish industry. Perhaps the solution lies in the establishment of a cold chain connecting the landing centres to the retail marketing centers. Unless the marketing of

frozen fish is adopted by the industry on a large scale for domestic consumption, it will be very difficult to stabilize the prices.

TRANSFER OF TECHNOLOGY TO INDUSTRY

The extension services are highly effective in disseminating scientific information on fish processing to the industry through publications, seminars and exhibitions, film shows, training courses, etc. The Central Institute of Fisheries Technology, the Central Food Technological Research Institute and the Marine Products Export Development Authority play vital roles in this transfer of technology.

QUALITY CONTROL AND PRE-SHIPMENT INSPECTION

Almost all marine products exported from India are subjected to compulsory quality control and pre-shipment inspection by the Government of India. This has helped in maintaining the high quality of products and the ability to compete with the developed countries in world markets.

Standards

The Indian Standards Institution (ISI) started to formulate standards for fish and fishery products in 1962. The specifications for frozen prawns (shrimp) and prawns (shrimp) canned in brine were published during this year. Since then, standards have been laid down for almost all types of fish and fishery products. In 1967, ISI formulated a code for sanitary conditions, handling and transport in the fish industry (Part 1, preprocessing and Part 2, sanitary conditions). Specifications for master cartons for export of frozen seafoods have also been formulated.

Compulsory quality control and pre-shipment inspection

Quality control and pre-shipment inspections were introduced initially on a voluntary basis with effect from 1 September 1963. In 1963, the Export Quality and Inspection) Act, 1963 (22 of 1963) was enacted and came into force from 1 January 1964.

The Act empowers the Government of India to name the products which should be brought under compulsory quality control and pre-shipment inspection, prior to export, and to specify the type of quality control and inspection or both. The Export Inspection Council and the Export Inspection Agencies under the Council are authorized to conduct the quality examination and issue the certificate against which the exports of the items under the Acts can be made.

Frozen shrimp and canned shrimp were the first to be brought under the Act. Later, many items were added:

- (1) Canned shrimp: Organoleptic tests were compulsory with effect from 15 March 1965. Bacteriological standards were introduced on 15 January 1968;
- (2) Frozen shrimp: Organoleptic tests were compulsory from 15 March 1965. Bacteriological standards for cooked frozen shrimp were introduced from 15 January 1968. Final notification regarding introduction of bacteriological standards was issued on 30 December 1969. Phase 1 (pathogenic bacterial test) was introduced from 1 August 1973. Phase 2 (total plate count) from 1 January 1974;
- (3) Frozen froglegs: Compulsory organoleptic tests were introduced from 1 March 1966. Bacteriological standards were enforced from 1 October 1969;
- (4) Frozen lobster tails: Both organoleptic and bacteriological tests were issued on 21 October 1970 and enforced with effect from 28 December 1971;

- (5) Dried fish: Export of dried fish to Sri Lanka was brought under quality control on a voluntary basis from 1 April 1967. Quality control was made compulsory to all destination with effect from 22 June 1970;
- (6) Dried prawns: Quality control was made compulsory with effect from 22 June 1970;
- (7) Dried shark fins and fish maws: Compulsory quality control was introduced from 12 January 1970;
- (8) Dried Bombay duck and laminated Bombay duck: Quality control was made compulsory with effect from 5 May 1973.

Preliminary notifications for bringing frozen pomfrets, cuttlefish and squid under the quality control scheme have been issued.

Criteria of quality

The physical, organoleptic, analytical and bacteriological aspects of a product are being examined. The suitability of marine products for export is determined on the basis of representative samples drawn from the lots under examination:

- (a) Physical: This includes factors such as size, grade, packing, etc.;
- (b) Organoleptic: Odour, flavour, texture, foreign matter, etc., are covered under this;
- (c) Analytical: This includes specifications for moisture, salt, sand, etc., in the case of products such as dried fish; and acidity, presence of metal, etc., in the case of canned shrimp;
- (d) Bacteriological: Standards have been prescribed for the total plate count for bacteria and specific organisms such as *E. coli*, *Staphylococcus* and *Salmonella* for all types of frozen shrimps, canned shrimps, frozen froglegs and lobster tails.

As an example, the specifications for frozen prawns (shrimps) are given below:

Serial Number	Characteristics	Whole and headless shell-on	Peeled, peeled and deveined and butterfly	Cooked
1	Colour of shell	Natural colour characteristic of freshly caught prawn		Natural colour characteristic of fresh cooked prawn
2	Dehydration	Reasonably free from dehydration	Reasonably free from dehydration	Reasonably free from dehydration
3	Colour of flesh	Characteristic of fresh prawn	Characteristic colour	Characteristic cooked colour
4	Black spot of shell or meat	Reasonably free from black spot	Nil	Nil
5	Texture of meat	Firm and consistent	Firm and consistent	Firm and consistent

6	Odour	Characteristic odour of fresh prawn	Absence of any off-odour foreign odour	Odour of fresh cooked prawn
7	Flavour	Characteristic of fresh prawn	Characteristic flavour	Characteristic flavour
8	Total plate count at 38°C/g (maximum)	1 000 000	1 000 000	100 000
9	<i>E. coli</i> count/g (maximum)	20	20	Nil
10	Coagulase-positive <i>Staphylococcus</i> count/g (maximum)	100	100	100
11	<i>Salmonella</i> and Arizona	Nil	Nil	Nil

Methodology of inspection

If the random samples drawn from each lot satisfy the above criteria, a certificate of inspection will be issued by the Export Inspection Agency against which the consignment can be shipped. The validity of a certificate will be two and a half months for frozen products, three months for canned products and one month for dried items.

Through cooperation between the exporting and importing countries, the standards of the importing countries can be agreed and incorporated into the Indian quality control standards for export.

Inplant inspection

Until recently pre-shipment inspection was made on finished products only. Now a scheme is being evolved for continuous inplant inspection. Under the scheme, only processing units approved by the Export Inspection Agency shall be eligible for processing fish and fishery products for export. To qualify for approval, a unit shall have certain minimum facilities. Standards have been prescribed for surroundings, construction and lay-out, processing areas, ceiling, wall and floor, fly proofing, vermin and animal control, lighting and ventilation, working tables and utensils, machinery, location of cold storage and warehousing, water and ice, sanitary facilities, personnel health and hygiene, etc.

The raw material will be inspected in the processing unit for quality and only after approval can it be processed. This, it is hoped, will improve the standards of quality of our products. Simultaneously a scheme for control of quality of the raw material at the landing centres and preprocessing centres is being worked out by the Marine Products Export Development Authority. The Authority has also recommended minimum hygienic standards for fishing vessels, processing plants, storage premises and conveyances.

Diversification of products

The most important product receiving the attention of the industry is the consumer pack, especially individually quick frozen (IQF) shrimps. However, progress could not be achieved because liquid nitrogen was not available. Efforts are made to process IQF shrimps using freon which will help to solve the problem.

It is generally accepted that canned sardines show great potential but the high price of aluminium alloy cans has hindered progress. Effective steps have to be taken to provide cheap containers so that the industry can fully utilize the rich resources of oil sardine available in the Indian Ocean.

Note

Statistics quoted in the paper are published by the Marine Products Export Development Authority, Government of India in various publications.

PRESERVATION AND TRANSPORTATION OF FISH IN BANGLADESH

by

M. Shahidullah
Fisheries Technological Research Station
Chadpur, Bangladesh

Abstract

Bangladesh has substantial resources of both freshwater and marine fish. Fishing is intensified during the winter months of the year. The surplus catches are usually cured and preserved by various traditional and modern methods. The products are marketed in the cities and other consuming centres where fish is scarce. The various methods of curing and preservation, and the problems of transportation are discussed.

INTRODUCTION

Geographically, Bangladesh is situated on the deltaic region of the great rivers of the Ganges, the Brahmaputra and the Karnafuli. These rivers and their innumerable tributaries flow into the Bay of Bengal. The rivers, the natural depression 'Beels and Haors', the low-lying paddy fields, the man-made tanks and ponds, and the Kaptai lake constitute the major sources of freshwater fish. A 500-km coastline on the Bay of Bengal is a potential source of marine fish. Fish is usually available cheaply and therefore preferred to meat.

In the humid tropics fish in a fresh condition is not always available. Major fishing grounds are far away from the cities and the consuming centres which are not easily accessible. Fishing is also seasonal. Seasonal abundance in certain places and a dearth of fish in others stimulates fishermen to preserve their catch. Common methods used for preservation are sun-drying, salting and smoking. Fresh fish are generally preserved in ice for local marketing. Modern methods of freezing and canning are practised only for certain species which are exported.

METHODS AND MATERIALS

Sun-drying

In Bangladesh, the winter months are dry, water levels recede and fish concentrate in the rivers, 'Beels and Haors'; the sea is also calm. Fishing is intensified in the fresh waters and in the sea during this season. The main fishing centres are far from railroads and steamer stations. Ice is not readily available and catches are preserved by sun-drying.

Sun-drying is the simplest and the cheapest method of preserving fish in Bangladesh. Freshwater fish are dried mainly in the districts of Sylhet and Mymensingh and marine fish in Chittagong and Khulna. The drying season extends from November to March. During sun-drying the percentage of moisture in the fish muscle is reduced from 75 percent to below 20 percent.

Big carps, sharks and other fish are beheaded and gutted; scales, viscera, etc., are removed and the fish are cut lengthwise into strips, joined at the tail ends. Catfish are simply gutted and their heads are left intact. Most small fish are dried whole but, in some cases, viscera are removed by thumb pressure. In most cases fish are not washed after gutting and beheading. In the early stages of drying the fish putrify and attract swarms of flies. Open yards, locally called 'khola', are selected by the curers for sun-drying. The fish are spread on mats on the ground or on raised platforms made of bamboo, or hung by bamboo networks or by ropes tied and stretched between bamboo poles. An old net is generally spread over the yard in order to protect the fish from birds. It takes about 5-6 days for complete drying of small fish and more than a week for large fish.

After drying, the fish are sometimes transferred to earthenware vessels which are buried underground for a few months. In some cases, however, trenches are dug and lined with several layers of mats. The dry fish are placed in the enclosure and covered with mats and soil. After a few months the product is taken out of the trench for marketing. During the treatment the product develops a desirable colour and odour.

The fish are marketed in the districts of Chittagong, Noakhali, Sylhet, Comilla, Rangpur, Dinajpur, Dacca and Mymensingh where the people are accustomed to eating dried fish. Dried fish are marketed mainly during the early monsoon months when fresh fish becomes scarce.

Salting

Hilsa (*Hilsa ilisha*), which constitutes 40 percent of the total catch, is the only species of fish which is processed by salting in Bangladesh. The peak fishing season for hilsa is from May to October. Hilsa is too oily for drying.

The methods used are dry salting and wet or pickle salting. For pickle salting, the fish are beheaded and scaled and the entrails are removed. The fish are then cut transversely into slices joined ventrally. Thus the slices look wider than the actual diameter of the fish and the salt easily penetrates into the muscle. The sliced fish is then salted with about 15 percent salt and stored in a canister to keep the pickle intact. For dry salting the fish are packed in bamboo or cane baskets and the pickle is allowed to ooze out. The salted hilsa is locally known as 'nona ilish'. Most consumers favour the product for its characteristic flavour and taste.

Smoking

Only shrimps are processed by smoking. During the months from May to October shrimps are abundantly available in the estuarine areas of the districts of Khulna and Bakerganj but drying is not possible in rainy weather and therefore shrimps are smoked. Small shrimps of the genus *Macrobrachium* (*M. lamarrie* and *M. dolichodactylus*) are generally smoked. Smoking is carried out in huts made of long grass and reeds; the walls are daubed clay and scaffolds made of bamboo are constructed inside the hut. Shrimps, either preboiled or pretreated with saline water, are spread on the scaffolds. Smoke is produced beneath by burning sawdust or rice husks until the shrimp are adequately smoked and dried. The smoked products are finally exposed to the sun for additional drying.

Icing

Fresh fish are generally preserved in ice for local marketing. There are only a few ice plants in the country; the total output is not adequate and prices are often high. Most ice factories are at the large fish landing centres, namely, Chandpur, Barisal, Khulna, Kuliarchar, Goalanda, Chittagong. Most factories produce block ice in sizes varying from 70 to 80 kg. Often the water used to make ice is taken from polluted rivers and ponds. Some use underground water containing an excess of mineral salts. The Fisheries Development Corporation and the Central Fisheries Cooperative Society have set up ice plants at Chittagong. Wherever available, ice is used for long-distance transportation of fish but is rarely used by the fishermen. Most fish is landed in a poor condition.

For packing fish, block ice is usually crushed with wooden hammers or clubs. Ice-crushing machines are rarely available. The quantity of ice is usually inadequate and no definite ratio of fish to ice is applied by the fish traders. The fish traders always try to pack as much fish as possible into the wooden box and usually too much pressure is applied when nailing the lid on the box. Thus fish are damaged by pressure and the sharp edges of the ice pierce the fish tissue causing further damage and bacterial attack. Ice often melts away completely before reaching its destination. Sometimes fish are packed in bamboo baskets with a small quantity of broken ice and covered and tied with sacks.

Freezing

The Fisheries Development Corporation, the Food and Allied Corporation, the Fishermen Cooperative Society and some industrial enterprises at Chittagong and Khulna produce frozen shrimp and froglegs. Shrimp of the genus *Macrobrachium* (i.e., *M. rosenbergii*, *M. villosimanus* and *M. malcolmsonii*) are frozen. The shrimp are beheaded by hand and preserved in ice at the catching grounds or collection centres and are then transported to the processing factories at Chittagong and Khulna. The common means of transportation are by train, launch, steamer and truck. The final dressing, washing and salting are done in the factory under sanitary conditions. The shrimp are then frozen quickly by contact-freezing. The frozen product is then glazed and packed in paper cartons and stored for shipment to other countries. The temperature of the cold store is generally maintained at -15 to -20°C . Live frogs are brought to the factories from various places and, after final dressing, the hind legs are frozen for export.

Canning

In Bangladesh, canning of fish is not well developed and there are only two canneries. Although they are essentially fruit canners, they also can hilsa and other fish. The Fisheries Development Corporation and some private enterprises plan to set up fish canneries at Cox's Bazar, Chittagong, Barisal and Chandpur to produce canned fish for export.

Mechanically-dried fish

The only mechanical fish drier in the country was operated by Khepupara Cooperative Society in the Petuakhali District. The drier was in operation for some time but the society stopped production because it proved uneconomical. The Fisheries Technological Research Station, under the Directorate of Fisheries, is in possession of a Torry kiln which is used for research and experimentation on the production of dried- and smoked-fish samples.

PROBLEMS OF TRANSPORTATION

Small boats are generally used to carry fish from the fishing grounds to the landing centres. Most of the boats are not mechanized or insulated. After landing at the collection centres, some of the fish go to the local markets but the major portion is transported to distant markets. Fish are generally transported by train, steamer and launch, and boats, etc. From Chandpur, the fish are carried by train, steamer and launch, from Kuliarchar, by train mostly and from Barisal, by steamer and launch. From Cox's Bazar and Kaptai fish are carried by trucks. In recent years the Fisheries Development Corporation introduced a number of insulated fish-carrying trucks to carry fish from Kaptai and Cox's Bazar to the markets of Chittagong and Dacca. In the past the Directorate of Fisheries had built insulated fish-carrier boats but these are no longer in use. Fish-carrying vans in the train are not refrigerated or insulated. The approximate times, from the important fish landing centres to the expected consuming areas of Bangladesh, by various types of vehicles are given in Table 1.

Table 1

Journey time between landing and consuming centres by train, launch and truck

Mode of transportation	Fish landing centres	Arriving station or consuming station	Approximate time of journey (h) (min)
Train	Chandpur	Laksam	2 – 05
		Chittagong	5 – 15
		Sylhet	10 – 30
		Chatak	12 – 30
		Mymensingh (via LKM-Bhairab)	9 – 00
		Bahadurabad ghat-Tistamuk ghat (via Mymensingh)	14 – 20
	Goalonda	Kustia (via Rajbari)	2 – 30
		Poradaha (via Rajbari)	3 – 00
		Jessore (via Poradaha)	6 – 00
		Iswardi (via Poradaha)	3 – 40
		Sirajgonj ghat (via Iswardi)	6 – 40
		Rajshahi (via Iswardi)	6 – 00
		Santahar (via Iswardi)	5 – 50
		Bogra (via Santahar)	7 – 00
		Parbatipur (via Santahar)	8 – 00
		Lalmonirhat (via Parbatipur)	11 – 30
		Rangpur (via Parbatipur)	9 – 00
		Dinajpur (via Dinajpur)	9 – 30
		Panchaghar (via Dinajpur)	16 – 30
	Khulna	Rajshahi (via Poradaha-Iswardi)	10 – 30
		Bogra (via Poradaha-Iswardi)	8 – 00
		Rangpur (via Poradaha-Iswardi)	11 – 00
		Dinajpur (via Poradaha-Iswardi)	11 – 30
	Chittagong	Dacca (via Feni-Comilla-Bhairab)	9 – 00
		Sylhet (via Comilla-Akhaura)	15 – 00
		Mymensingh (via Bhairab)	11 – 00
	Kuliarchar	Bhairab	0 – 35
		Dacca (via Bhairab)	5 – 00
		Chittagong (via Bhairab)	8 – 00

Launch	Narayangonj	Bahadurabad (via Dacca-Mymensingh)	9 - 15
	Khulna	Chandpur	14 - 00
		Dacca	19 - 00
	Barisal	Chandpur	7 - 30
		Dacca	12 - 30
	Chandpur	Dacca	5 - 30
Truck		Narayangonj	4 - 30
	Chittagong	Cox's Bazar	8 - 30
	Rangamati	Chittagong	2 - 30
		Dacca	11 - 00
	Kaptai	Chittagong	2 - 30
		Dacca	11 - 00
	Cox's Bazar	Chittagong	5 - 30

CONCLUSION

Transportation of fresh fish from catching centres to the consuming areas is a difficult problem due to the non-organized fishing and very limited transport facilities. Fishing should be organized, the fishing boats should be mechanized and ice should be supplied to the fishermen in the catching centres. Rapid means of transport with refrigerated or insulated holds to carry ice may help but more ice factories and cold stores should be set up close to the landing centres. In the case of block ice, crushers should be provided. Refrigerated fish vans, refrigerated holds in the launch or steamer and insulated trucks or a cold chain system should be employed to carry fresh fish to the distant places. Finally the consuming cities and markets should have cold storage facilities to preserve the fish prior to final marketing.

A PRELIMINARY SURVEY OF THE PRAWN TRAWLING INDUSTRY IN SABAH AND ITS NON-COMMERCIAL FISH CATCH

by

P.J.I. Snell
Fisheries Department
Kota Kinabalu
Sabah, Malaysia^{1/}

Abstract

Six survey trips were conducted over a one-year period on three commercial trawlers in the Kota Kinabalu area to determine the percentage weight of marketable and unmarketable catch and the approximate composition of the catch. A further survey trip around the entire coast was conducted using Fisheries Department trawlers and the breakdown of the catch into both family and categories of marketable and unmarketable catch was determined. Based on these data and on questionnaires returned by the fishermen, a calculation of the total weight of fish discarded in Sandakan, Sabah's major prawn trawling centre, was made. The data are discussed in relation to the present status of the Sabah trawling industry and the possibility of making greater use of this resource.

INTRODUCTION

The existence of considerable prawn trawler by-catch has been noted in a number of Southeast Asian countries (Campbell, 1975). In view of the considerable importance of the prawn trawling industry to the economy of Sabah, it was decided to conduct an initial study of the amount and composition of this by-catch prior to the investigation of possible uses for this raw material.

THE SABAH PRAWN TRAWLING INDUSTRY

Sabah is situated in the northern part of Borneo, bordering on the Indonesian state of Kalimantan in the south, and has a population of 836 519, which is concentrated primarily in the coastal areas, due to the inaccessibility of the interior. The economy is based on the export of raw materials such as timber, palm oil, cocoa, prawns, copper concentrates and oil.

Trawlers were first introduced in the early 1950s but a rapid increase in trawling activity occurred only during the early 1960s with the establishment of the first prawn freezing factories. During 1976, 2 316 tonnes were exported at an estimated total value of M.\$ 22 032 262 (U.S.\$ 9.3 million). Because the market price for prawns is far higher than the price of the bulk of the fish landed (principally, *Dorosomatinal*, *Leiognathidae*, *Nemipteridae* and *Sciaenidae*), almost all the trawling effort is directed toward the prawn fishery (Shaari *et al.*, 1976). Since the east coast has long been recognized as the best breeding area for prawns (possibly because of its extensive mangrove swamps), trawlers are concentrated on this coast. The recognized trawling areas around the coast are shown in Figure 1. Details of the number and sizes of licensed trawlers operating from each fishery centre together with estimates of the number of unlicensed trawlers are given in Table 1.

Two types of trawling license are issued; one allows trawling outside the 12-mile limit and the other permits trawling outside 5 fathoms and excludes certain other areas which are believed to be fish breeding grounds or traditional fishing grounds for artisanal fishermen. Fishing regulations, however, have been widely disregarded due to the limited number of policing vessels but, recently, the Fisheries Department has begun to take strong action against offenders and has introduced several new license conditions in an attempt to protect in-shore areas.

1/ The paper was written during the author's assignment in Sabah with the U.K. Voluntary Service Overseas (VSO)

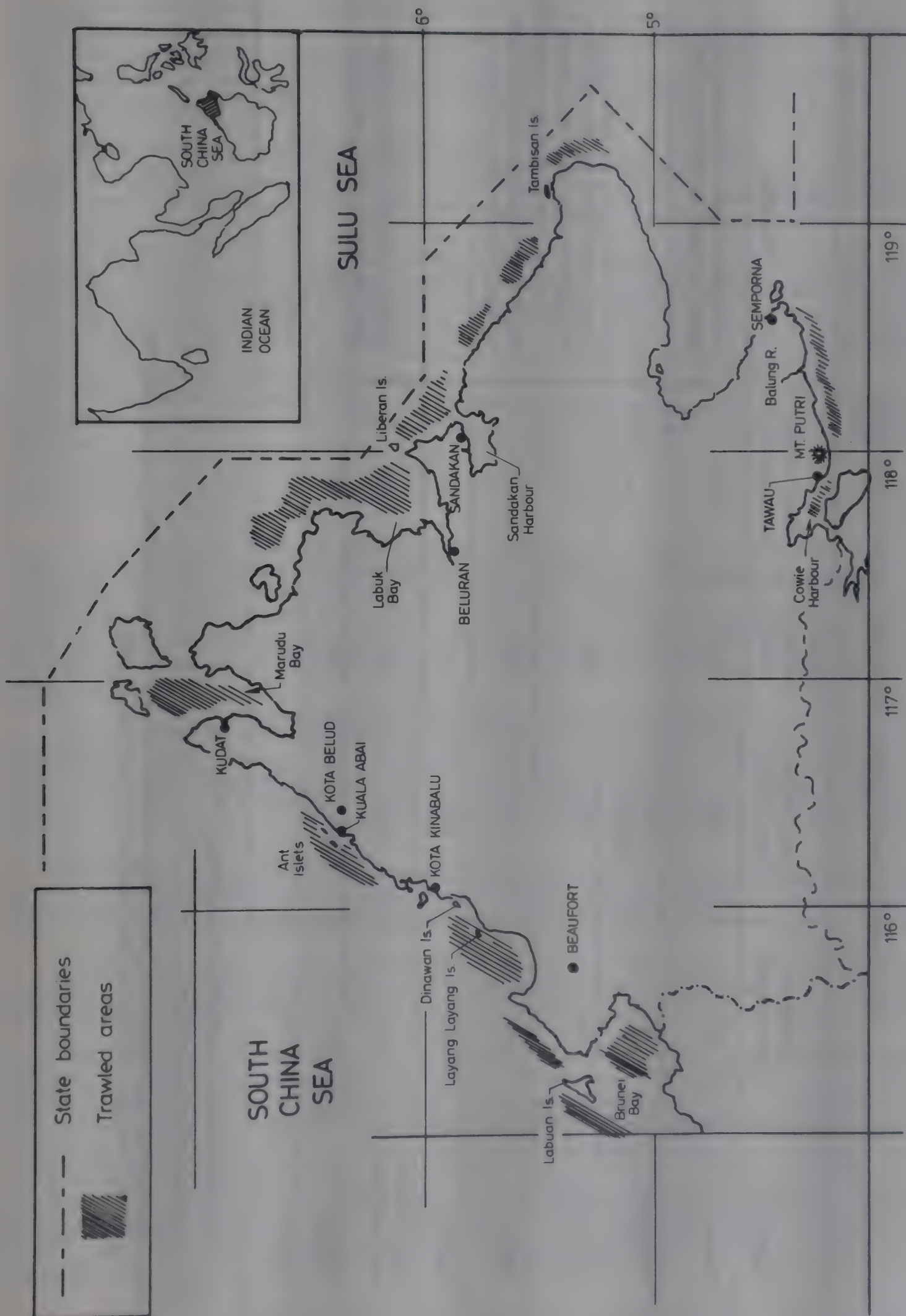


FIG. 1. SABAH - MAJOR TRAWLING AREAS

Table 1

The number of trawlers operating from fishing centres in Sabah in 1976

District(s)	Number of licensed boats ^{a/}	Average engine horse power ^{b/}	Number of unlicensed boats ^{c/}	Average engine horse power ^{c/}	Remarks
Tawau	68	52	19	12	Horse power figure for licensed boats based on figures for 28 boats only
Semporna	8	Not available	—	—	
Sandakan	174	79	230	20	Horse power figure for licensed boats on figures for Sandakan and Beluran
Beluran	31	79	300	20	Horse power figure for licensed boats on figures for Sandakan and Beluran
Kudat	12	50	6	20	
Kota Kinabalu and Kota Belud	41	69	8	20	Horse power figure for licensed boats based on figures for 10 boats only
Beaufort	16	Not	10	20	
Labuan	10		—	—	Licensed boats not operating during 1978

a/ Draft of Fisheries Department Annual Report, 1976

b/ Records of licensing officers

c/ For the east coast estimates of local fisheries officers were used (after consultation with local fishermen)
For the west coast and Murudu Bay estimates by the author are given

Although no figures are available on the different forms of trawler ownership, it is believed that the majority of boats are owned by the skipper. If the owner is not present on the boat, the crew will often sell the prawn catch and not declare the full proceeds to the owner. Although bones schemes have been used successfully by fleet owners on the west coast, these are less effective on the east coast where a number of prawn freezing factories are competing for the catch.

Due to the heavy emphasis on prawn trawling, most trawling gear is designed primarily for prawns as described by Chin and Goh (1967) and the trawlers may be either single or double rigged. There is, however, a limited number of trawlers of Peninsular Malaysian origin, which are designed for catching fish.

On-shore facilities vary widely and depend on the location of the prawn freezing factories. At the wharves of prawn freezing factories in Sandakan, Tawau and Labuan, trawlers are able to moor and obtain various supplies including crushed ice which is sold at M.\$ 2.00 per 100 lb (U.S.\$ 0.84 per 45 kg). However, in areas such as Kota Kinabalu, where the freezing factories are not close to the sea, there are often no suitable wharves and uncrushed ice may cost as much as M.\$ 5.00 per 100 lb (U.S.\$ 2.11 per 45 kg). Unless landing facilities and cheap ice are available, fishermen will often use insufficient ice and deliver their fish catch to various minor centres. The fish markets have limited cold store facilities and the catch stored overnight by fishmongers is relatively small. Medium-sized businesses freeze some of the larger fish for export but the value of this export is far lower than that of prawns.

The prawn trawler by-catch

The heavy fishing for prawns provides a large catch of the more common demersal fish. When trawling was first introduced, one condition of the trawling license was that all such fish should be brought to market but, because the smallest fish could not be sold, this condition is no longer enforced. Fish are discarded at sea if they would taint the rest of the catch when stored with them (i.e., Ariidae and Euselachii), if they are considered too small for human consumption (i.e., most species of Leiognathidae and juvenile Nemipteridae and Sciaenidae) or too bony to be acceptable (i.e., Trichiuridae and Synodontidae), or because they are poisonous (i.e., Lagocephalidae).

Although small amounts of fish from the major fish markets are used for animal feed, these are believed to be fairly insignificant. However, in the Kota Kinabalu area, a farmer buys up to 500 kg per day of small fish direct from the fishermen for drying over wood fires and rough milling into fishmeal. The supply of fish is erratic and is believed normally to be considerably less than this. It is not known if any similar operations exist on the east coast.

In addition trawlermen will often keep the unmarketable fish from the last haul of the day and exchange these for fruits with people living in small villages along the coast. Such fish, although unmarketable in urban centres, may be saleable in smaller rural markets.

Although a number of fishermen have made inquiries about buying modern fish meal processing plants only one factory has been built. This has been set up in Tawau with secondhand Taiwanese equipment and is reported to be capable of handling 1500 tonnes of fish per year. It has not, however, started operation.

Few figures exist of the proportion of fish discarded by prawn trawlers. Between 1962 and 1965 survey figures from Fisheries Department vessels, reported by Chin and Goh (1967), indicated that the percentage of unmarketable fish varied between 68.0 and 83.5 percent along the west coast and the percentage of prawns in the catch varied between 1.9 and 45.9 percent. A trawl survey, conducted in 1972 between 5 and 60 nautical miles from the west coast, indicated that the amount of 'trash' fish in the total catch varied between 0.0 and 89.8 percent in each haul whilst there was 44.1 percent 'trash' fish in the total catch (Shaari *et al.*, 1976). Neither survey gave a species breakdown of the unmarketable fish catch and it is not known whether the criteria for judging marketability were applicable to the local market since one of the species listed as marketable in the latter survey is never landed by trawlers operating from Kota Kinabalu. No survey figures existed for trawler catches on the east coast.

Factors affecting the trawler by-catch

The size of fish brought to market by trawlermen will depend on the supply of fish which is in turn affected by the weather, tides and the quality of the fishing grounds. Areas of the east coast, particularly in the Tawau area, are noted for their very strong tides and a number of smaller-engined boats are unable to go out during spring tides or rough weather. Also, it is generally believed that prawn catches are better after heavy rain and during slack tides so the fishing effort is greater during such periods and more larger fish are caught.

The types of fish supplied to market will vary with consumer preferences which often differ for the various ethnic groups. Ariidae, which are not very bony but have a 'muddy' taste, are acceptable for the curry dishes of non-Chinese races but are not liked by the Chinese who predominate in urban areas. Since they will taint other fish when stored with them, trawlers operating from urban centres will not normally bring any of these fish back to port. In addition, because of the greater affluence of consumers in urban areas, fish which could be sold at rural markets such as the weekend markets in Tuaran and Kota Belud would be considered too small by consumers in Kota Kinabalu.

SURVEY METHODS

Since it was not possible to accompany commercial trawlers from all the major trawling centres in the state, it was decided to concentrate on three commercial trawlers based in Kota Kinabalu and, subsequently, to conduct a survey of commercially fished trawling grounds using Fisheries Department trawlers around the entire coast.

As it was not practicable to sort catches on boats of less than 10 m in length, the initial survey was conducted on three relatively large trawlers. The first (boat 1) was a double-rigged 15.5 m trawler, owned by the Fisheries Cooperative in Kota Belud and the crew was paid on a flat rate weekly basis. The second (boat 2) was a 14.5 m single-rigged trawler; the skipper was paid a generous bonus based on prawn catch. Both of these trawlers were permitted to fish within the 12-mile limit. The last trawler (boat 3) was 14 m long and had been brought from Penang by its skipper/owner. It was designed for catching fish and its license permitted trawling only outside the 12-mile limit.

Six survey trips were made at intervals of approximately two months so that two trips were made on each trawler at approximately six-monthly intervals. No attempt was made to influence the choice of trawling ground for each trip and the crew was allowed to sort out the marketable fish and prawns from each haul. Then the remaining catch was weighed and a small sample retained for sorting by family on deck. The weight of each family in the sample was recorded and the total weight of each family in the haul was estimated from the percentage breakdown of the sample. The fish were identified using a simple guide of Shaari (1971) and their identification was checked in Kota Kinabalu using the more exhaustive keys of Fischer and Whitehead (1974) and Weber and de Beaufort (1911). The total weights of various categories of marketable catch were measured at the end of the trawling trip and recorded.

It was not possible to use one Fisheries Department vessel for the round coast survey since the boats were either unfit for long trips or were in great demand by other officers. Five trawls of one-hour duration were conducted in each of nine major trawling grounds around the coasts at depths of between 6 and 40 m. All trawlers were single-rigged and the nets had been constructed by Fisheries Department staff apart from one (FF6) which had been made commercially in Sandakan. A line to depth ratio of 5:1 was used for all trawls, this being the ratio used by nearly all commercial trawlers in Sabah. The entire catch was classified, wherever possible, by family and into marketable/unmarketable for each family; the weights of each classification were recorded. This classification into marketable and unmarketable fish was made according to an average subjective standard based on that used by the three commercial trawlers in the first survey. In a few cases it was impracticable to sort the entire catch; the unsorted fish were weighed and discarded. The percentage breakdown of the total haul was then estimated from the catch which was sorted. Identification of the fish was carried out on deck using two keys of Fischer and Whitehead (1974) and Shaari (1971).

No accurate calculation of annual trawler fish catches is made by the Fisheries Department because of the large number of unlicensed trawlers and the inaccuracy of the statistical returns by fishermen. A questionnaire was therefore sent to each licensed trawler owner in the state requesting details of the number of hours trawled in each month, from July 1976 to June 1977 inclusive, and the weight of fish sold on the fish market in each month. It was thought that this questionnaire, which was far simpler than the normal departmental form and did not inquire about the prawn catch which is of much higher value, might be answered more accurately by fishermen.

SURVEY RESULTS

Commercial trawlers

The results of the initial survey in the Kota Kinabalu area are shown in Table 2 and Table 3. Both trips on boat 3 were conducted over a single night since this boat had no wharf at which to moor and so had difficulty obtaining ice. For this reason Ariidae and sharks could be stored on deck without danger of tainting the remainder of the catch.

The sample of catch was sorted into the most common families present; small quantities of other families were classified as 'remainder'. However, after two survey trips it was noted that Ariidae, flatfish (var.), Leiognathidae, Nemipteridae, Pomadasysidae, Sciaenidae, Synodontidae and Trichiuridae were present in large quantities and, to ensure that accurate total weights were measured, they were weighed even when present in very small amounts. The weights of other families continued to be taken only if present in large amounts within a haul; the total catch weight for such families during a trawling trip may therefore be slightly inaccurate.

Fisheries Department trawlers

The results of the round coast survey are shown in Tables 4, 5 and 6. The breakdown of the non-fish catch has not been given since it would be misleading. Commercial trawlers normally carry out a series of trial trawls until a school of prawns is located and then trawl repeatedly over them. However, during this survey the widest possible area was covered and the catch of prawns would not therefore be typical of commercial operations. The high non-fish catch in the three areas close to Sandakan was principally composed of crabs (var.) but in the area south of Sandakan Harbour a large number of shovel-nosed lobsters (Scyllaridae) were also caught.

In most areas it was possible to sort the entire catch. However, it was necessary to restrict sorting to a section of the catch in the following areas: Murudu Bay (28.3 percent), Labuk Bay (67.3 percent), Tambisan Island to Sandakan Harbour (77.0 percent) and Cowie Harbour (76.7 percent) (the figures in brackets denote the percentage of catch which was sorted).

Questionnaires

The number of correctly completed questionnaires returned was 103. Since Sandakan is the major prawn centre and returned 51 of the questionnaires, it was decided to estimate the annual weight of by-catch in this area. Assuming a binomial distribution of the percentage breakdown of fish into marketable and unmarketable categories, it was found that there were no significant differences between the three fishing areas near Sandakan which were surveyed (Tambisan Island to Sandakan Harbour, Sandakan Harbour to Libaran Island and Labuk Bay). The total percentage breakdown of fish into marketable and unmarketable categories was 6.5 and 93.5 percent respectively. To give a conservative estimate of the percentage of fish discarded, the percentage figure of unmarketable fish was reduced by three standard deviations to 87 percent.

Linear regression analysis of the hourly catch rates calculated from the returned statistics initially gave a low correlation coefficient. However, it was noted that one company which sent in returns for seven trawlers consistently reported a lower catch rate than the other owners. Linear regression of returns of the other 44 boats for engine horse power against hourly catch rate in pikuls/h gave a best fit straight line which almost passed through the origin, had a slope of 9.97×10^{-4} and a correlation coefficient of 0.593. The average number of

hours trawling per year for all boats in Sandakan and Beluran was assumed to be the same as for these 44 boats (1 214 h/year) and the total landings of marketable fish were calculated from the figure for numbers of trawlers and trawler horse power given in Table 1 using the relationship: hourly catch rate (pikuls/h) = Boat engine horse power $\times 10^{-3}$

The annual catch of marketable fish by Sandakan and Beluran trawlers was estimated at 1 967 tonnes/year and, therefore, if 87 percent of the fish caught were unmarketable, 13 165 tonnes of fish were discarded during that period in the Sandakan area.

DISCUSSION

In the survey of commercial boats it was notable that boat 3 brought the largest proportion of fish to market; this may be due to the different net design used. However, the lower overhead costs of one-night trips in which ice is not used and the fact that this boat was owned by the skipper may also have influenced the classification of fish.

In considering the catch breakdown of by-catch on commercial trawlers in the Kota Kinabalu area it should be noted that the method of sorting will have led to some inaccuracy. However, it was impossible to carry out more careful sorting without interfering with normal fishing operations. In spite of this, it was clear that *Leiognathidae* was the most commonly caught family of unmarketable fish but *Ariidae*, *Nemipteridae*, *Pomadasyidae* and *Synodontidae* were also present in sizeable quantities. *Trichiuridae* were occasionally present in very large quantities. Other families present in sufficient quantities in the Kota Kinabalu area to be worthy of further study were *Mullidae*, flatfish (var.), *Platycephalidae* and *Sciaenidae*.

The by-catch in all areas surveyed in the departmental trawlers was high relative to that recorded on the commercial trawlers. However, fishermen claim that at the time of this survey their catches were also very poor. *Leiognathidae* were present in the largest quantities overall, although only relatively small quantities were found close to Sandakan. *Ariidae*, *Nemipteridae* and *Synodontidae* also formed a significant proportion of the by-catch although in each case they were totally absent in some areas. *Pomadasyidae* were present in almost all areas but were caught in fairly small quantities, and the catch of *Trichiuridae* varied widely. *Lagocephalidae* and *Sciaenidae*, which had not figured prominently in the earlier surveys on commercial vessels, were found in large quantities in the by-catch in certain areas of the east coast. Other families which were present in sizeable quantities in some areas were *Apogonidae*, flatfish (var.), *Mullidae* and rays (var.).

Bearing in mind the differences in trawl speeds and net sizes it would appear that the highest catch rate was obtained in Murudu Bay and the next highest from Kuala Abai to Ant Islets. The survey results for in-shore waters therefore resemble those of Shaari *et al.*, (1976) for waters further off-shore. It is of interest that the catch rates per swept area for the east coast fishing grounds were lower even though these have traditionally been regarded as the best fishing grounds.

Due to the lack of information on the by-catch breakdown for prawn trawlers there are few comparable figures for other countries. Jones (1976) has noted that the percentage of 'trash' fish in commercial trawl landings was 54 percent in Malaysia in 1973, 40 to 50 percent in Thailand in 1974 and between 22 and 33 percent in the Philippines in 1975. Although these figures are lower than those obtained for Sabah it is quite possible that trawlers are discarding large amounts of such fish at sea. Surapon and Montol (1974) report that the catch of 'duck' fish on five trawlers in the Gulf of Thailand varied between 55.4 and 95 percent of the total fish catch. Thai marine fisheries statistics produced by the Department of Fisheries (1972) indicate that *Saurida* spp. and *Trichiurus haumela* are listed separately from 'trash' fish whereas in the Kota Kinabalu area even the largest of these are not taken to market by commercial trawlers. It therefore seems likely that some of the by-catch in Sabah would be marketable for human consumption in countries with a higher population density.

From data available on the composition by family of the trawler by-catch in different countries, the family breakdown in Sabah seems to resemble closely that of Peninsular Malaysia, as reported by Jones (1976). How-

ever, there are also many similarities with the occurrence of dominant family 'trash' fish at Kangar fish market in Singapore as reported by the Marine Fisheries Research Department (1975) and the composition of 'duck' fish in Thailand as reported by Sarapon and Montol (1974).

The striking difference between Sabah and other countries would seem to be that no market exists for such fish. Jones (1976) states that throughout the South China Sea "it appears that nothing is too small to land" whilst in Singapore it is reported that there are never any surplus trash fish landed (Marine Fisheries Research Department, 1975). In this context it is important to state that the estimate of fish discarded by boats operating in the Sandakan area, as given above, is thought to be an underestimate for two reasons. Firstly, statistical returns from trawler owners often give an unrealistically low report of the catch and, for this reason, large correction factors have to be computed when estimating the annual prawn catch for departmental statistics. Secondly the author believes that the estimate of unmarketable catch made during the round coast survey was conservative by commercial standards and yet, in the calculations, it has been assumed to be too generous.

Therefore, there would appear to be a large unutilized resource of fish in Sabah. It seems likely that, with cheaper trawler overhead costs for such commodities as ice, and with better marketing facilities, a certain amount of this resource could be sold in less affluent rural areas even if it were not acceptable to consumers in urban areas. Also, it might be possible to export certain species which are not acceptable to consumers in Sabah, although this may not be economic. Alternatively, if there are facilities for the production of animal feeds, such as fishmeal and fish silage, this may encourage the trawlermen to land otherwise unmarketable fish. However, the operator of the simple fishmeal plant in Kota Kinabalu reports that trawler operators are reluctant to land their by-catch for his price of M.\$ 7.00 per pikul (U.S.\$ 3.00 per 60 kg) and it is possible that, since prawns provide such a good return to the fishermen, there will be little interest in less profitable outlets for their catch.

The development of meat/bone separators has opened up the possibility of using species of unmarketable fish for making minced products. Since the use of the by-catch for human consumption in a processed state would probably give a larger return to trawlermen than its use for animal feeds, the development of widely acceptable products from separated minced flesh is of great importance to the trawling industry in Sabah.

CONCLUSION

The percentage of unmarketable fish in the catch on six trips of commercial trawlers operating out of Kota Kinabalu, Sabah, was found to vary between 58.7 and 79.4 percent. Ariidae, Leiognathidae, Nemipteridae, Pomadasysidae and Synodontidae were found to predominate within the by-catch of fish. A subsequent survey trip around the coast indicated that the percentage of fish catch which was unmarketable varied between 70.4 and 95.6 percent although it is recognized that, at the time of the survey, poor fishing results were obtained throughout the state. The principal families of fish identified within the by-catch were Apogonidae, Ariidae, flat-fish (var.), Lagocephalidae, Leiognathidae, Mullidae, Nemipteridae, Pomadasysidae, rays (var.), Sciaenidae, Synodontidae and Trichiuridae. The use of this resource might be increased markedly by the development of marketing and processing facilities within the state.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the kind permission of the Director of Fisheries, Mr. Chin Phui Kong, to proceed with the work, the assistance of various members of the Fisheries Department, Sabah, for their help with the identification of fish species and their information on the local trawling industry and the advice of Mr. J. Pope in the preparation of this paper.

REFERENCES

- Campbell, M. (Ed.), Stable tropical fish products. Report on a workshop held in Bangkok, Thailand, 8-12 October 1975. 1974. Ottawa, IDRC, 27 p.
- Chin, P.K. and S.K. Goh, Prawn otter trawl fishery in Sabah, Malaysia. Jesselton, Fisheries Branch, Department of Agriculture, 25 p.

- Fischer, W. and P.J.P. White head (Eds.), FAO Species identification sheets for fishery purposes. Eastern Indian
1974 Ocean (fishing area 57) and Western Central Pacific (fishing area 71). FAO, Rome, pag. var.
- Jones, R., Mesh regulations in the demersal fisheries of the South China Sea areas. Manila, South China Sea Fish-
1976 eries Development and Coordinating Programme
- Shaari, M.B.S.A.L., A guide to trawl species in Penang waters. Kuala Lumpur, Malaysia, Ministry of Agriculture
1971 and Lands
- Shaari, M.B.S.A.L. *et al.*, Demersal fish resources in Malaysian waters. 6. First trawl survey off the coasts of
1976 Sarawak, Brunei and the west coast of Sabah. Kuala Lumpur, Malaysia, Ministry of Agriculture and
Rural Development, 64 p.
- Singapore Marine Fisheries Research Department, Marine Fisheries Department annual report, 1975. *Annu.Rep.*
1975 *Mar.Fish.Res.Dep.Southeast Asian Fish.Dev.Centre*, (1975):48 p.
- Surapon, V. and E.S. Montol, Baby trawl fishery in the east coast of the Thai waters. Bangkok, Department of
1974 Fisheries (Internal report)
- Thailand, Department of Fisheries, The marine fisheries statistics 1972 based on the sample survey. Bangkok,
1972 Department of Fisheries, Ministry of Agriculture and Cooperatives
- Weber, M. and L.F. De Beaufort, The fishes of the Indo-Australian archipelago. Leiden, E.J. Brill, 8 vols.
1911-1936

Table 2
Catbh breakdown from three commercial trawlers

Trawler	Boat 1	Boat 2	Boat 3	Boat 1	Boat 2	Boat 3
Dates	4+5.8.76	5+6+7.10.76	10+11.12.76	26+27+28.3.77	3+4.4.77	31.5.77+1.6.77
Length of bottom line (metres)	25	27	23	25	27	23
Average trawler speed (km/h)	3.1	3.1	Not known	3.3	3.5	Not known
Time net in water (h : min)	10 : 45	16 : 55	9 : 0	19 : 30	14 : 15	9 : 30d/
Hourly catch rate (kg/h)	142.0b/	75.1	51.5	36.0	36.0	100.2d/
Percentage catch breakdown:						
Prawns	2.6	4.0	6.4	8.4	8.8	5.5
Cephalopoda	—	—	—	—	—	0.3
Crabs	—	—	2.7	—	—	—
Marketable fish ^{a/}	23.2	29.1	34.9	25.8	11.8	24.6
Ariidae	—	—	5.8	—	—	)
Sharks	—	1.8c/	4.2	—	—	) 2.2
Stromateidae	—	1.2	—	—	—	)
Others	23.2	26.1	24.9	25.8	11.8	22.4
Unmarketable catch	74.2	66.9	56.0	65.2	79.4	69.6
Exchanged with villagers	8.0	16.2	—	—	3.7	—
Thrown away	72.2	50.7	56.0	65.2	75.7	69.6

a/ This figure does not include fish eaten by the crew (less than one percent)

b/ Only one net effective on one haul of 1 h 25 min due to twisting of the lines

c/ Figure includes sharks which followed the net in and were caught on hand lines by the crew

d/ Catch from last 3 h-haul confiscated by police due to fishing in a restricted area. Catch rate is therefore based on the first two hauls only

Table 3

Unmarketable catch breakdown from three commercial trawlers

Trawler	Boat 1 ^{e/}	Boat 2	Boat 3 ^{f/}	Boat 1	Boat 2	Boat 3
Dates	4+5.8.76	5+6+7.10.76	10+11.12.76	26+27+28.3.77	3+4.4.77	31.5.77+1.6.77
Percentage breakdown to family of unmarketable catch ^{a/}						
Ariidae ^{b/}	18.4	8.6	9.1	8.2	14.7	8.7
Carangidae	0.7	—	—	—	—	—
Clupeidae	4.4	—	—	—	—	—
Engraulidae	1.0	—	—	—	—	—
Flatfish (var.) ^{b/}	1.3	2.5	4.7	6.5	3.3	2.6
Gerreidae	0.1	2.8	—	—	—	—
Lagocephalidae	0.3	0.3	—	2.0	—	14.1
Leiognathidae ^{b/}	3.7	39.6	48.0	12.7	16.0	18.9
Mullidae ^{c/}	—	—	—	1.7	2.3	5.9
Nemipteridae ^{b/ c/}	5.0	10.5	1.4	4.9	2.4	6.1
Platycephalidae	0.2	0.1	21.3	—	—	—
Pomadasyidae ^{b/ d/}	8.2	7.8	9.9	10.2	7.7	3.5
Rays (var.)	3.1	—	—	9.1	—	—
Sciaenidae ^{b/ d/}	0.8	2.4	4.2	13.1	26.9	1.4
Sharks (var.) ^{b/}	—	0.7	—	—	—	—
Sphyracnidae	0.4	—	—	—	—	—
Synodontidae ^{b/}	0.4	8.4	—	12.9	1.8	0.5
Theraponidae	0.3	—	—	0.3	—	6.2
Triacanthidae	—	0.6	—	—	—	—
Trichiuridae ^{b/}	45.3	11.4	—	2.7	2.1	—
Remainder	6.5	4.4	1.5	15.5	22.7	32.1
Hourly catch rate of unmarketable catch (kg/h)	105.2	50.3	28.8	23.5	28.6	69.8

^{a/} Breakdown based on sample size of between 2.2 and 37.5 percent by weight of the catch. Average size was 10.3 percent^{b/} These families were noted to be present in sizeable quantities on the first two trips and in all subsequent trips their weight was accurately recorded even when very small quantities were present^{c/} For sale purposes *Nemipterus* spp. and similarly coloured *Upeneus* spp. are classified together. Only from trip three onward were they differentiated

- d/ During early trips the crew would often sort *Sciaenidae* and *Pomadasy* spp. together and percentage breakdown figures for these are probably slightly inaccurate for the first three trips
- e/ Due to lack of time the percentage breakdown of one 1 1/2 h trawl was assumed to be identical to the subsequent trawls
- f/ The total weight of one trawl of 2 h 15 min was estimated by the captain while its breakdown was based on that of the other two trawls

Table 4

Catch breakdown from Fisheries Department survey around the Sabah coast

	Brunei Bay	P. Layang to P. Dinawan	Kuala Abai to Ant Islets	Murudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to Sandakan Harbour	Mt. Putri ^{c/} to Balung River	Cowie Harbour
Trawler	FF7	FF7	FF8	FF6	FF6	FF6	FF6	FF5	FF5
Date(s)	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Average depth (metres)	24	20	14 ^{b/}	17	9	15	15	13 ^{b/}	12 ^{b/}
Hourly catch rate (kg/h)	21	47	57	112	60	30	77	19	18
Catch rate per swept area (kg/km ²) ^{a/}	240	710	1 100	1 210	790	350	770	230	270
Marketable fish (percent)	27.2	11.8	9.9	22.7	7.8	3.5	3.1	27.4	3.7
Unmarketable fish (percent)	64.7	86.4	89.5	75.7	81.9	51.6	66.5	70.1	63.8
Non-fish (percent)	8.2	1.8	0.5	1.6	10.3	44.8	30.5	2.5	32.5

- a/ The speed of the boat was estimated from the time taken for a floating object to pass the boat. Due to the inaccuracy of such a method the catch rates are only given to the nearest 10 kg/km². The area swept per hour was estimated as the boat speed x length of the trawl bottom line
- b/ The depths on these trips were estimated from charts since the survey boats did not have working echo sounders
- c/ The results of the survey in this area may not be typical since the tidal currents were very strong at the time and the crew were inexperienced and seasick

Table 5

Marketable fish catch breakdown from Fisheries Department survey around the Sabah coast

Area surveyed	Brunei Bay	P. Layang Layang to P. Dinawan	Kuala Abai to Ant Islets	Marudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to Sandakan Harbour	Mt. Putri to Balung River	Cowie Harbour
Date(s) of survey	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Percentage breakdown to family of marketable catch:									
Carangidae	—	—	3.0	12.0	2.5	8.5	—	—	—
Clupeidae ^{a/}	2.3	0.5	5.2	4.4	58.6	63.0	—	10.1	31.1
Drepanidae	12.6	22.9	—	—	—	—	—	—	—
Ephippidae	—	0.6	—	—	—	—	—	—	—
Flatfish (var.)	8.8	10.8	17.4	9.8	1.9	15.9	35.3	—	—
Gerreidae	—	1.2	4.3	2.6	—	—	—	0.2	—
Lactaridae	—	—	2.0	1.2	12.7 ^{c/}	—	—	0.6	—
Leiognathidae	3.8	—	11.6	0.8	—	—	—	2.1	—
Lutjanidae	3.2	—	—	1.4	—	—	6.8	16.3	—
Muraenesocidae ^{b/}	—	—	—	—	—	—	—	32.6	—
Nemipteridae	3.6	37.6	48.1	53.4	1.0	—	57.9	—	—
Pomadasyidae	—	19.3	2.0	—	—	—	—	—	—
Priacanthidae	—	—	—	—	1.7	—	—	—	—
Sciaenidae	1.2	0.6	5.5	6.3	10.9	5.3	—	28.1	26.9
Scombridae	—	—	0.8	—	3.9	—	—	3.4	21.8
Serranidae	64.5	—	—	0.9	—	—	—	4.1	—
Sphyraenidae	—	1.6	—	5.6	6.9	7.4	—	—	—
Stromateidae	—	—	—	1.5	—	—	—	2.4	20.2
Theraponidae	—	4.9	—	—	—	—	—	—	—
Catch rate per swept area (kg/km ²)	70	80	110	270	60	10	20	60	10

a/ Since *Dorosomus* spp. are rarely caught near Kota Kinabalu, the classification of marketable and unmarketable sizes was not known. Since there was relatively little size variation, 50 percent of the fish caught were placed in each category

b/ Since *Muraenesox* spp. are rarely caught on the west coast, the larger fish caught were categorized as marketable on the advice of the crew

c/ Possible mistaken identification

Table 6
Unmarketable fish catch breakdown from Fisheries Department survey around the Sabah coast

	Brunei Bay	P. Layang to P. Dinawan	Kuala Abai to Ant Islets	Murudu Bay	Labuk Bay	Sandakan Harbour to Libaran Island	P. Tambisan to Sandakan Harbour	Mt. Putri to Balung River	Cowie Harbour
Date(s) of survey	19.7.77	20+21.7.77	11+12.8.77	8.8.77	6.8.77	5.8.77	3.8.77	16+17.8.77	25+26.7.77 15.8.77
Percentage breakdown to family of unmarketable catch:									
Apogonidae	12.3	0.9	0.1	0.3	0.3	3.5	1.4	0.5	1.2
Ariidae	9.2	5.4	19.3	4.6	—	—	2.0	2.5	4.9
Balistidae	0.3	—	—	0.4	—	—	—	—	—
Carangidae	0.7	0.1	0.2	0.7	1.6	12.4	2.1	0.2	3.0
Chirocentridae	—	0.1	—	—	1.0	1.9	0.5	—	—
Clupeidae	4.1	0.2	0.7	1.7	6.5	6.8	—	5.3	10.6
Diodontidae	0.6	—	—	—	—	—	—	—	—
Drepanidae	4.4	0.3	*	0.1	0.2	—	0.3	0.4	1.0
Echineidae	—	—	—	—	—	—	0.1	—	—
Engraulidae	0.3	1.0	—	—	0.1	0.7	—	0.8	—
Ephippidae	0.3	—	—	—	—	—	—	—	—
Flatfish (var.)	2.1	1.7	—	1.1	4.2	6.9	9.3	0.1	0.2
Gerreidae	—	1.3	1.1	0.5	1.4	3.4	0.9	—	2.5
Lactariidae	—	0.8	0.4	0.1	—	—	—	1.4	—
Lagocephalidae	5.5	2.5	1.2	0.9	3.8	14.7	2.9	0.6	12.6
Leiognathidae	14.4	56.0	63.4	33.8	56.4	3.0	1.5	11.2	19.4
Lutjanidae	0.6	—	—	0.8	2.1	—	1.3	—	—
Megalopidae	—	0.1	—	—	—	—	—	—	—
Mullidae	0.8	4.8	1.7	14.8	4.0	7.3	1.9	0.2	3.2
Muraenocidae	—	—	—	—	—	—	—	—	0.9
Nemipteridae	15.5	11.9	0.3	10.0	1.6	5.7	23.5	—	—

Platycephalidae	0.1	0.3	—	0.7	0.5	1.5	0.3	—	0.4
Polynemidae	—	—	0.1	—	0.1	—	—	0.3	—
Pomadasyidae	1.9	1.9	2.6	6.2	3.6	0.8	2.7	0.3	—
Priacanthidae	1.0	—	—	0.7	—	0.6	—	0.3	—
Rays (var.)	3.2	3.5	—	2.1	2.3	—	23.3	—	1.4
Sciaenidae	0.5	2.7	0.8	0.6	1.4	1.9	—	50.9	27.6
Scombridae	0.1	—	—	0.1	—	0.6	—	—	1.0
Scorpaenidae	—	0.1	—	0.6	—	—	—	—	—
Serranidae	0.5	—	—	0.1	—	—	—	—	—
Sillaginidae	—	—	—	—	1.4	—	—	—	0.6
Sharks (var.)	—	—	—	—	0.1	—	0.7	1.3	—
Sphyracnidae	—	1.2	—	—	0.1	—	—	—	—
Stromateidae	—	—	—	—	*	—	—	—	1.0
Synodontidae	15.5	0.7	1.9	16.4	5.9	25.9	21.0	—	0.2
Theraponidae	6.1	2.3	0.7	2.1	1.1	1.1	*	0.8	3.9
Triacanthidae	0.3	—	0.2	—	1.0	0.5	3.3	—	—
Trichiuridae	—	0.2	5.1	1.0	—	—	—	22.5	3.3
Uranoscopidae	—	—	—	—	—	0.5	—	0.2	—
Remainder ^{a/}	—	—	0.1	—	0.2	0.3	1.0	0.3	1.2
Catch rate per swept area (kg/km ²)	160	610	980	910	650	180	510	160	170

^{a/} Fish were placed in this category if they were relatively uncommon and, therefore, of little commercial interest and if they were difficult to identify

Signifies that although the family of fish were available in the area they were present as less than 0.05 percent of the total catch for the area

CURRENT STATUS OF THE FISH PROCESSING INDUSTRY IN THAILAND

by

B. Saisithi
Fishery Technology Development Division
Department of Fisheries, Bangkok, Thailand

Abstract

The present situation with regard to availability of raw material is discussed, particularly in view of the establishment of the 200 mile economic zone. Fresh fish handling is also reviewed.

The increasing demand for fish protein has resulted in product diversification. Fish processing and product development in Thailand are also therefore discussed.

INTRODUCTION

Thailand ranks among the top ten fishing nations of the world with an annual production of 1.5 million tonnes. Of this production about 0.6 million tonnes is caught outside Thai waters. In the near future Thailand has to face the problem of a 200 mile economic zone which will result in a declining production of fish, the cheapest source of protein. It is anticipated that improved utilization could substitute about 0.1 million tonnes of the lost production.

The consumption pattern of Thai people, like those of other people in developing countries of the region, show that fresh fish is preferred first and then traditional and non-traditional products. In recent years there has been a change in consumption pattern due to increasing exports and a high demand for diversified products.

RAW MATERIAL AVAILABILITY

The annual fish production and values from 1971 to 1975 are shown in Table 1. However, it is expected that production will decline as a result of the establishment of a 200 mile exclusive economic zone. Improved utilization, such as upgrading quality and minimizing waste is one way to reduce the effect of this decline.

Table 1

Fish production and values from 1971 to 1975

Year	1971	1972	1973	1974	1975
Quantity (tonnes)	1 587 077	1 679 540	1 678 901	1 510 466	1 555 300
Value (million bahts) ^{a/}	5 528	6 307	8 209	5 983	7 194

a/ Baht 1 = U.S.\$ 0.0496 (April, 1978).

Fish handling has improved in recent years resulting in better quality raw material and consequently increasing the availability of raw materials for processing. At present there are about one-hundred refrigerated trucks in Thailand which have a net payload of 10 tonnes each. Also, most fishing boats with a total length of 25 m or more have some sort of refrigeration system on board. The fishermen and the middlemen are fully aware of how to improve the quality of fish, but there are still some socio-economic problems to be solved; handling problems on the fishing boats must also be solved. Transportation has been improved to a certain degree; for example, squids and cuttlefish are packed and distributed by truck in large wooden tubs which contain ice and water. Trucks are used in preference to trains which take a longer time.

FISH PROCESSING AND PRODUCT DEVELOPMENT

Fish processing in Thailand has changed little due to the high demand for export products and the limited availability of raw material. Table 2 shows the percentages of utilization of marine and freshwater fish from 1966 to 1975. The percentages of fish utilized as fresh and frozen only apply to marine fish; none of the freshwater fish is frozen. Almost all the marine frozen fish is exported and this trade increases each year. Therefore, there is a tendency for the consumption of marine fish to decline and of freshwater fish to increase relatively.

As 90 percent of the total catch is marine fish, it is necessary to concentrate mainly on the consumption pattern and to improve the utilization of marine fish. Table 2 shows the figures for traditional products made from marine fish such as dried and salted, steamed or smoked, shrimp paste, dried shrimp and fish sauce. The miscellaneous group consisting of diversified and some non-traditional products increased steadily from 1966 to 1972, and dropped between 1973 and 1975. The percentage of fishmeal consumption is as high as 40 percent of the total fish production; hence it plays an important role in the fishing industry. Some species of this by-catch which are currently used for fishmeal production could be utilized for human consumption.

EXPORTED FISHERY PRODUCTS

Fishery products are ranked third on the list of export values. The statistical data in 1976 (Table 3) indicate that the value of exported fishery products from Thailand was 3.085 million bahts (equal to U.S.\$ 15 million). The quantities and values of fish and fishery products exported from Thailand from 1972 to 1976 are also shown in Table 3. In 1974 both quantity and value dropped due to the oil crisis. The products which were influenced by this crisis were live fish, preserved fish (Group A) and frozen shrimp (Group D). Products in Group B (fish sauce and fishmeal) increased tremendously in 1975 and 1976, respectively. This is due to the demand in foreign markets. Products in Group C (traditional products) still play important roles in export and increased in quantity and value, except dried mussels which declined gradually but began to pick up in 1976. This change was due to parasites. It is expected that after the parasites are brought under control, the production of mussel and other kinds of shellfish will increase. Frozen products such as fish, shrimp, cuttlefish and squid are the most important group and more than half the total quantities and values fall into this group.

It should be emphasized, therefore, that in 1975 products in Group E, which consisted of preserved crustaceans and mollusks, dried jelly fish and canned fish, became more important. Preserved crustaceans and mollusks production also increased tremendously in 1976. Diversified products such as seasoned, fried and canned squid and cuttlefish, some condiment products which are produced from dried and/or smoked shrimp all fall into the group of preserved crustaceans and mollusks. These diversified products have become a very popular seafood for both domestic and export consumption in the last few years. Data are not available to indicate the quantities of these products.

CONCLUSION

The availability of raw material in the country is limited. Diversified products which have been modified from traditional products are accepted by Thai people. It is expected that in the future these products will play an important role in both domestic and export consumption.

Table 2

Percentage of utilization of marine and fresh-water fish from 1966 to 1975

Percentage of fish utilized	1966		1967		1968		1969		1970		1971		1972		1973		1974		1975	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Fresh and Frozen	46.98	66.23	55.90	60.67	51.69	68.69	46.20	81.06	47.46	72.84	41.62	71.18	40.82	84.02	37.88	84.38	34.56	79.11	37.37	77.49
Dried and Salted	9.29	9.31	8.20	10.32	6.51	5.39	2.10	11.44	4.93	16.34	4.39	13.71	5.36	8.40	4.96	8.82	5.77	11.82	6.67	12.71
Steamed or Smoked	1.68	5.10	1.06	6.04	1.62	22.59	2.05	4.18	0.08	5.65	1.20	7.09	1.01	5.07	0.88	4.01	1.15	6.41	1.36	6.59
Shrimp paste	1.51	0.26	1.30	0.28	1.22	0.28	1.27	0.21	1.21	0.16	1.01	0.28	1.27	0.12	1.46	0.13	0.89	0.30	1.38	0.11
Dried shrimp	—	—	—	—	2.06	0.09	1.28	0.13	1.39	0.12	1.21	0.12	1.25	0.08	1.16	0.06	1.76	0.08	1.88	0.14
Fishmeal	28.44	0.80	17.80	0.81	16.15	0.20	25.14	0.25	24.28	0.18	21.51	1.04	23.63	0.14	37.90	0.04	41.69	0.02	41.74	0.08
Fertilizer	—	—	—	—	0.03	0.03	1.91	0.03	0.04	0.04	0.32	0.19	0.02	0.02	0.03	0.03	0.07	0.03	0.09	0.01
Fish sauce	7.29	0.25	6.58	2.77	5.90	1.99	4.65	1.76	3.80	3.83	7.28	4.94	7.28	1.76	4.07	2.31	4.76	2.05	5.71	2.70
Miscellaneous	4.81	18.05	9.16	19.11	14.82	0.74	15.40	0.94	16.81	0.84	21.46	1.45	23.34	0.39	11.66	0.22	9.35	0.18	3.80	0.17

M — Marine fish

F — Fresh-water fish

Table 3
Quantities and Values of Fish and Fishery Products
exported from Thailand from 1972 to 1976

Fish and Fishery Products	Group	1972		1973		1974		1975		1976	
		Q	V	Q	V	Q	V	Q	V	Q	V
Live fish	A	630	13.5	4 961	23.1	403	12.6	585	14.6	692	16.6
Preserved fish		2 049	15.1	16 919	133.6	5 086	56.4	4 066	71.8	4 664	108.9
Fish sauce	B	989	3.8	1 003	4.9	910	5.1	1 551	13.3	1881	17.4
Fishmeal		28 194	90.4	24 324	125.6	21 946	129.4	26 919	135.8	49 083	248.6
Dried mussels	C	205	5.4	120	2.7	101	2.5	85	1.8	97	2 2.3
Salted or dried shrimp		577	19.9	985	40.3	1 090	51.1	1 467	70.5	1 501	84.5
Salted or dried cuttlefish and squid		2 752	103.5	1 338	56.0	1 532	84.1	1 382	102.8	1 452	130.4
Frozen fish		26 188	64.9	23 022	87.6	28 365	100.8	28 726	122.4	31 263	162.8
Frozen shrimp	D	6 726	339.7	14 875	803.8	10 251	603.7	13 541	891.2	15 217	1 347.3
Frozen cuttlefish and squid		13 230	140.9	14 411	281.8	15 992	367.8	16 087	512.8	21 287	631.7
Preserved crustaceans and mollusks	E	841	10.1	2 175	90.6	2 545	135.5	3 022	161.4	5 066	309.1
Dried jelly fish		—	—	—	—	—	—	550	7.9	872	12.6
Canned fish		—	—	—	—	—	—	—	—	379	12.9
Total		82 381	807.2	104 133	1 650.0	88 221	1 549.0	98 000	2 106.3	133 454	3 085.1

Q — Quantities in metric tons

V — Values in million bahts

FISH UTILIZATION AND MARKETING IN THE IPFC REGION

by

E.C. Sison and I.F. Tanudra
Department of Food Science and Technology
University of the Philippines at Los Baños College, Laguna

Abstract

This paper presents the fish utilization and marketing situation in the IPFC region. The data were obtained from FAO statistics and from statistical reports of the countries covered. Due to differences in the reporting system, direct comparison is difficult. Hence, the information cited should be considered with caution and taken only as indicative rather than as absolute facts.

THE IPFC REGION

The IPFC region is one of the most important fishery regions in the world because it covers a wide area of tropical seas extending from the Indian Ocean in the west to the Pacific Ocean in the east. It covers the territorial waters of countries such as Bangladesh, Burma, Sri Lanka, Thailand, Singapore, Malaysia, Indonesia, Kampuchea, Vietnam and the Philippines.

The climate can be classed as tropical with temperatures varying from 15° to 30°C. The northeast monsoon brings rains to the eastern side from November to March while the southwest monsoon brings rain to southern regions from June to September.

Most of the countries in the IPFC region may be classified as developing and economically poor. The economic profile of selected countries is shown in Table 1. The *per caput* GDP range from U.S.\$ 75 for Bangladesh to U.S.\$ 1 626 in Hong Kong and the population density may be as high as 5 per ha as in Bangladesh. Animal protein consumption is also very low; for instance, 5.6 g/day for Indonesia and Sri Lanka and 6.5 g/day for Bangladesh.

Fishing in the IPFC region is rather primitive and the exploitation of fishery resources is far from optimum. Due to the heavy concentration of fishermen near the sea the coastal areas may be over-fished resulting in poor catches by the fishermen. Likewise, the lack of transport facilities hinders the effective distribution of fish to the interior population centres. Low production and limited markets tends to aggravate the economic plight of the fishermen. Hence, they could not afford to invest in the modern facilities which are needed to fully exploit the available fish resources in the deeper waters.

Despite the differences in religion and culture among the various countries in the region, the typical diet consists of rice and fish. Rice is the primary source of energy and fish serves as the principal source of animal protein. In all the countries where data were available, fish supplies more than 50 percent of the animal protein in the diet.

Fish is important not only because it is abundant but because it is the cheapest protein food available. While prices of exportable species have risen significantly, prices of most of the marine and freshwater species have remained stable in recent years.

FISH RESOURCES AND THEIR UTILIZATION

The fish resources may be categorized into marine, littoral, mangrove swamps, and inland resources. In general, all the countries within the IPFC region can be considered to be rich in fishery resources. In recent years also many coastal countries have considered declaring jurisdiction over the surrounding waters up to 200 miles thus expanding significantly their marine resources. The summary of the resources of the different countries are shown in Table 2.

Table 1

Economic Profile of selected countries

	UNITS	BANGLADESH	BURMA	HONG KONG	INDONESIA	KAMPUCHEA	MALAYSIA
I. POPULATION							
a. Total	(in millions)	74.990 ^{a/}	30.310 ^{a/}	4.250 ^{a/}	129.100 ^{a/}	6.968 ^{c/}	11.650 ^{a/}
b. Population growth rate	%	2.2 ^{e/}	2.4 ^{e/}	1.8 ^{e/}	2.4 ^{e/}	2.8	2.9 ^{e/}
II. FOOD CONSUMPTION							
a. Protein consumption	g/day	41.2	56		48.8		56.5
b. Animal protein consumption	g/day	6.5	9.8		5.6		16.5
c. Fish protein consumption	g/day	3.3	4.6		3.9		8.3
d. Total calories	cal/cap/day	2 024	2223		2 126		2 574
e. Animal products	cal/cap/day	76	116		52		290
f. Fish products	cal/cap/day	19	26		23		53
III. ECONOMIC CONDITION							
a. Per caput GDP (national)	U.S.\$	75 ^{d/}	102 ^{c/}	1 626 ^{a/}	123 ^{b/}	130 ^{f/}	750 ^{a/}
IV. LAND AREA							
a. Total	'000 km ²	144.776	678.033	1.034	1 904.569	181.035	332.648
b. Land area, per caput	'000 m ²	1.93	22.37	0.24	14.75	25.98	28.55

a/ 1974

b/ 1973

c/ 1974-75

d/ 1972-73

e/ 1970-74 annual average

f/ 1971

Table 1 (concluded)

	UNITS	PHILIPPINES	SINGAPORE	SRI LANKA	THAILAND	VIETNAM	REGION
I. POPULATION							
a. Total							
b. Population growth rate	(in millions) %	41.500 ^a / 3.0 ^e	2 220 ^a / 2.7 ^e	13.490 ^a / 1.9 ^e	41.000 ^a / 3.1 ^c	41.850 ^b / 2.6	397.328 2.5*
II. FOOD CONSUMPTION							
a. Protein consumption	g/day	50.1		45	50	38.4	
b. Animal protein consumption	g/day	18.8		7.1	18.8	18.8	
c. Fish protein consumption	g/day	9.4		5.6	6.9	13.1	
d. Total calories	cal/cap/day	1 971		2 019	2 382	2 406	
e. Animal products	cal/cap/day	210		85	173	193	
f. Fish products	cal/cap/day	57		18	43	81	
III. ECONOMIC CONDITION							
a. Per caput GDP (national)	U.S.\$	338 ^a	2 521 ^a	239 ^a	291 ^a	230 ^g	
IV. LAND AREA							
a. Total	'000 km ²	300.00	0.586	65.610	514.000	333.039	4.45
b. Land area, per caput	'000 m ²	7.23	0.26	4.86	12.58	17.18	

a/ 1974

b/ 1973

c/ 1974-75

d/ 1972-73

e/ 1970-74 annual average

f/ 1971

g/ 1964-73

* average

Table 2

Fishery resources

	UNITS	BANGLADESH	BURMA	HONG KONG	INDONESIA	KAMPUCHEA	MALAYSIA
I. COASTLINE	'000 km	0.7	2.8		35.8	0.4	3.4
II. MARINE AREA (total)	'000 km ²	4 026.9			5 000		
a. Continental shelf	'000 km ²	103	2.50	1.5	1 382		418
III. MARINE RESOURCES							
a. Total sustainable yield	'000 t				5 800		
b. Present landing	'000 t	247.2a/		33.31b/	892.9a/	25b/	525.7a/
c. Level of utilization							
d. Production <i>per caput</i>	kg	3.3		7.8	6.9	3.6	45.1
IV. DEMERSAL RESOURCES							
a. Sustainable yield	'000 t	373					32
b. Present catch	'000t			83.7b/	50.0b/	8.7	223.7b/
c. Level of utilization	%						699
V. PELAGIC RESOURCES							
a. Sustainable yield	'000 t						430
b. Present catch	'000 t			28.3	283.2	9.7	138.8
c. Level of exploitation.	%						32
VI. INLAND RESOURCES							
a. Total inland production	'000 t	727			424.108	60	
b. Rivers, creeks, canals	'000 ha	830.08					
c. Lakes and impoundments	'000 ha	292.98			27		
d. Rice paddy		2 800.00			3 000.00		
e. Mangrove, swamp, tidal flats, etc.		182.98			6 000.00		150
f. Fishpond	'000 ha		3	1 085	275.604		
g. Level of utilization	%				4.6		
h. Total fishpond production	'000 t				139		

a/ 1974

b/ 1971

The demersal species of the region may be characterized as exhibiting little migration, slow growth rates and late maturity. Because of these characteristics, spawning season and site are stable and there is little resistance to fishing pressure and these species can readily be overexploited (Aoyama, 1973).

Pelagic species, on the other hand, have large schools and are widely migratory. The reproduction rates are very fast and they are therefore very difficult to overexploit provided illegal fishing is prevented.

Indonesia

The seas around Indonesia are believed to be richer than those surrounding other tropical islands. Thus the country has unusually rich and varied stocks of fish and other marine animals within an area of 5 million km² which was shown by a recent survey to have a potential of 0.84 tonnes per km². Indonesian authorities believe that these waters could yield 5.8 million tonnes of fish per year. Currently only 13 percent of the stocks are being exploited, partly due to the predominance of traditional fishing methods.

Indonesia has a total aquaculture resource of more than 12 000 hectares of which only 275 hectares are currently utilized. Potential sites for aquaculture are considerable at more than 10 million ha, but not all of this can be fully utilized.

Malaysia

Malaysia is surrounded by three seas: the South China Sea in the east, Straits of Malacca in the south, and the Indian Ocean in the west. Its coastline is 3 814 km and its coastal area is about 120 000 km². It has rich marine resources but the results of a survey conducted by the Fisheries Research Institute of Malaysia from 1970-71 show that the west coast in-shore fishery has reached a serious level of exploitation. Reported demersal fish landings from the west coast are approximately 93 000 tonnes while the sustainable yield is estimated to be only 32 000 tonnes. Pelagic fish landings are approximately 78 000 tonnes while the annual sustainable yield is estimated at 58 000 tonnes. This condition is attributed to the continuous use of traditional fishing practices which have confined catching within the 19-km zone, leaving ample unexploited resources beyond this zone.

Malaysia's aquaculture resources are only partially exploited. Approximately 1 300 ha are fully developed while 375 000 ha still await development.

Philippines

The Philippines has 24 600 km of coastline and some 1.9 million km² of territorial waters. There is an extremely narrow continental shelf and the marine fishery is concentrated in the shallow waters of the Sulu Sea (868 800 km²), the China Sea (36 100 km²), the Pacific Ocean (34 800 km²) and the Visayan Sea (12 000 km²), of which only 30 percent is currently utilized.

Aquaculture in the Philippines is based mainly on the use of 171 446 ha of fishponds. Fishpen culture has expanded from 40 ha in 1969 to 2 000 ha in 1973 and the potential for expansion in aquaculture is about 493 626 ha.

Bangladesh

Bangladesh has a coastline of about 700 km and a continental shelf of 103 000 km² of which 37 000 km² is no deeper than 50 m and the depth of the rest of the area ranges from 50 to 200 m. The continental shelf and the estuaries have been found to be rich in marine resources.

The Bay of Bengal, with an area of 1.42 million ha, is the main source of marine fish resources in Bangladesh. A trial trawling operation in this area reported an average catch of 500 kg per hour per boat. This survey estimated that the standing demersal fish stock in the continental shelf ranges from 264 000 to 373 000 tonnes.

The extensive inland waters of Bangladesh have a total area of about 1.5 million ha which includes the following:

	<i>Area (ha)</i>
a. Rivers, streams and canals	830 080
b. Estuaries and other brackish water	182 900
c. Ponds, tanks and dams	76 485
d. Natural depression on bows and other natural impoundments	292 988
e. Karnaphuli hydroelectric reservoir	90 648

Total	1 473 101

Much of this area is not used but could be developed through the installation of appropriate infrastructure. There are also 2.8 million ha of paddy fields where fish culture could be alternated with rice during the monsoon season.

Thailand

Ninety percent of the fish production of Thailand comes from marine waters and 10 percent from the inland waters. The coastline is 2 600 km; the extensive inland waters have an area of 1.29 million ha. Approximately 69 000 ha of fresh water and 10 000 ha of brackish water are used for aquaculture. There are also 200 000 ha of irrigated ricefields which can be developed for fish production. However, fish production from irrigated ricefields is estimated at only 30 kg per ha with minimal management.

Sri Lanka

Approximately 91 percent of the total fish landings of Sri Lanka come from the sea. Marine fisheries development is hindered by fuel shortages and lack of capital investment. The Government is considering the development of inland fisheries to meet the ever-increasing demand for fish; 200 000 ha of fresh water and 288 000 ha of brackish water are suitable for aquaculture. Currently only 10 000 ha of the available 288 000 ha suitable for aquaculture are being exploited.

Vietnam

Previous hostilities in Vietnam have restricted fish production and resulted in serious damage to fish hatcheries, fish stocks and equipment. The adverse effects of pollution to some inland and estuarine fisheries have been noted by Lagler (1972) and plans for the better management of fish stocks as well as the development of fish culture have been initiated by the Mekong Delta Committee.

FISH PRODUCTION

Seasonal variation

Fish production in the IPFC region is considerably influenced by climate. Because the coastal fishermen use small boats, they can venture into the open sea only when conditions are calm. Also, since many use lights to attract the fish, the catch is heavier during dark nights. Likewise, inland fish production is affected by monsoons. Fish grow during the flood season and must be harvested when the water dries up in summer.

The whole of Sri Lanka experiences rain during November, December and January. The summer monsoon brings rain to the west zone during May, June and July. The seas to the west of the island are relatively calm during the months of September to March during the northeast monsoon. From April to August, the seas on the west coast are rough due to the southwest monsoon which makes fishing difficult. Fishermen migrate from one coastal region to another where the sea is calm and as a result high yields are possible.

Bangladesh has a humid, tropical monsoon climate and is often subject to tropical cyclones which cause floods in the low-lying area in the coastal parts of the delta. In Dacca the average temperature during the month of January is 19°C and from May to September the average temperature is 28.8°C.

The climate of Indonesia is dominated by consistently high temperatures and heavy rainfall during all seasons. The eastern half of Java, Bali, Southern Sulawesi and Mecca Tenggara undergo a clearly marked dry season during the southeast monsoon between June-July and September-October. In Pontianak, located almost exactly on the equator, on the west coast of Kalimantan, monthly rainfall varies from 16 cm in July to 40 cm in December. The average monthly temperature varies from 25°C in December to 26.6°C in July. Total annual rainfall in Pontianak is 320 cm. Mean monthly temperature in Surabaya, east of Java, fluctuates between 26° and 26.6°C. Average monthly rainfall is measured at more than 24 cm during the months of December to March and at less than 5 cm in October.

Placid waters prevail in the west coast of Malaysia whereas the East Coast is exposed to the full force of the northeast monsoon during the months of October and November

The dry season in Thailand extends from November to April when the average water temperature is 27.5°C with the lowest temperature observed during the month of December at 24° to 26°C. Rains prevail in the months of June-August when water temperatures vary between 28° and 32°C.

The mountainous character of the Philippines plus the fact that it is situated at the intersection of the southwest monsoon and the northeast tradewinds cause a marked variation in both the total amount and the seasonal incidence of rainfall. The western part of the country receives most of its rain during the southwest monsoon (late June to late September) the eastern side experiences rain during the months of November to March when the influence of the northeast tradewinds is at its greatest.

The southwest monsoon brings rain to Vietnam during the months of May to September whereas the dry season is from November to March when the prevailing wind is mainly northeast. A hot dry season from February to April precedes the rain. Rainfall may be as much as 276 cm per year. During the dry season the humidity in Saigon is as low as 72 percent but rises to 98 percent during the rains.

Fish production

Within the region, marine fish production has levelled off or even decreased in recent years but inland fisheries and aquaculture production have risen (Table 3). Landings have declined particularly in Indonesia and Thailand. In 1974, these countries had an aggregate production of about 2.5 million tonnes of which 81 percent was marine fish and 19 percent from inland waters and aquaculture.

Table 3

Fish landings ('000 t)

	Total landing				
	1970	1971	1972	1973	1974
Thailand	1 477.7	1 587.1	1 678.9	1 678.9	1 626.0
Bangladesh		814	814	818	820
Burma	311.4	319.8	329.1	338.0	307.6
Philippines	988.884	1 023.095	1 122.410	1 264.837	1 268.368
Indonesia	1 228.5	1 244.5	1 267.8	860.0	829.9
Sri Lanka	98.1	85.2	101.9	100.7	110.7
Vietnam		587.5	677.7	707.2	
Malaysia		367.8	358.7	444.7	525.7

In 1974, the total fish landings for Malaysia amounted to 525 700 tonnes of which 52 000 tonnes came from Sarawak, 32 000 tonnes from Sabah and 441 800 tonnes from West Malaysia. Approximately 74 percent of the total annual catch is attributed to West Malaysia, 16 percent to Sabah and the remaining 10 percent to Sarawak. An increase of 43 percent was observed between 1971 and 1974 and total fish landings are expected to rise due to increased fishing activity and other improvements. A considerable increase, from 14 600 to 52 000 tonnes, was recorded during the period; an increase of 261 percent in Sarawak. On the other hand, an increase of only 17.7 percent was observed in Sabah within the same period.

Fish production in Bangladesh was fairly stagnant in 1971 and 1972 at 814 000 tonnes. The catch then increased slightly by 0.7 percent from 1972 to 1974. Approximately 89.5 percent of the total catch is contributed by inland fisheries.

Total fish production in Sri Lanka has increased by 13 percent from 1970 to 1974. However, the increase in the total production is not sufficient to meet the ever-increasing local demand and almost 50 percent of the locally consumed fish is imported. Development of inland fisheries is imperative to accelerate the annual growth in fish production.

Total fish production in the Philippines has increased from 988 884 tonnes in 1970 to 1 268 368 tonnes in 1974, an increase of 28 percent. The contribution of the marine fishery has receded over the years and the Government is developing inland fisheries to offset the decreasing marine catch.

A 3 percent increase in the total fish production of Indonesia was recorded in 1970 to 1972. However, the total catch for 1974 was 892 900 tonnes, a drop of 29.5 percent from the 1 267 800 tonnes in 1972. The Indonesian fish resources are still capable of greater exploitation and an increase in production could be realized without leading to serious depletion.

Thailand's fish production increased by 15 percent from 1970 to 1972. From 1 678 000 tonnes in 1972, the catch stagnated in 1972-1973, and then decreased in 1975. This can be attributed to the continuous decline in marine landings due to overexploitation.

Fish landings in Vietnam are increasing. In 1970 the recorded production was 587 500 tonnes which grew to 707 200 tonnes in 1973, an estimated increase of 20 percent.

DEMAND AND CONSUMPTION LEVELS

Pattern of consumption

The consumption of fish differs according to the availability of supply and the eating habits of the people. In countries with long coastlines people prefer marine fish, but in countries with large freshwater areas, for instance Kampuchea and Bangladesh, freshwater species are preferred. Species which are abundant throughout the year are consumed primarily in the fresh form but seasonally abundant species are processed into various products for later consumption. Salting, drying, smoking and cooking are typical methods of preservation.

Generally, consumers prefer fresh fish to processed products and many consumers are willing to pay a premium price for fresh fish. In Malaysia, 65 percent of the fish landed in 1973 were marketed in the fresh form; Thailand was similar and in the Philippines, 80 percent is sold fresh while the remainder is dried. A small portion is diverted to salting and smoking. So-called "trash" fish is made into fish sauce and fish paste.

The trend in Indonesia is from processed to fresh fish; 40 percent of the total catch is marketed in the fresh form while the remainder is cured into dried, salted, boiled salted, and dried fish.

In Bangladesh also the consumers prefer fresh fish particularly from freshwater fish.

Dried fish is the most economical and convenient source of animal protein in Sri Lanka. Almost half of the total requirement is in this form and 80 to 90 percent is imported.

Per caput consumption

Malaysia's *per caput* fish consumption for 1973 was 26.6 kg and from 1965 to 1973 a 65 percent increase was recorded. Increase in *per caput* consumption is expected largely in the population centres and in rural areas where sponsored economic programmes are in operation.

The lowest *per caput* fish consumption in the region is in Bangladesh at 9 kg per year. This is followed by Indonesia which is also quite low at 10.5 kg annually, although consumption varies greatly from one part of the country to another.

In Sri Lanka, the *per caput* fish consumption ranges from 15 to 20 kg per year which includes imports equivalent to about 10.7 kg. Imports are now being curtailed to reduce foreign exchange expenditure.

Thailand's *per caput* fish consumption declined by 22 percent, from 25.8 kg in 1970 to 20.1 kg in 1973. This was due to a decrease in the total supply of fish.

Among the developing countries in the region, the Philippines has the highest *per caput* consumption; 31.36 kg per year was recorded in 1974 and the estimated growth rate is 10.6 percent per year.

PROCESSING AND UTILIZATION

Table 4 shows the utilization of marine and freshwater species in the different countries of the region.

Most fish is consumed fresh but of the processed products fish sauce is predominant. In predominantly Muslim areas, boiled salted fish is a common product.

Table 4

Processing and utilization

	BURMA	HONG KONG	INDONESIA	KAMPUCHEA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM
Marketed fresh	83.7	129.4	699.5		369.8	1 038.6	13.0	600	55.9
Frozen			3.0		5.5			65	1.1
Cured	288.0	7.6	650.4		46.7	259.7		223	22.1
Canned			24.0		0.2			566	0.2
Reduced		5.2			2.0				8.8
Miscellaneous purposes	62.1	1.4	15.0				6.2	174	11.9
Offal for reduction			(11.0)						
Dried and salted								272	
Fish paste									

"Trash" fish accounts for almost 40 percent of the total production; in Thailand, 50 percent of the trawl catch consists of "trash" fish which is used as feed for catfish and ducks. In the Philippines such fish is processed into fish sauce and fish paste. In West Malaysia where low-grade fish represent 75 percent of the catch, studies are geared toward developing new methods of processing to make products for direct human consumption.

The production of dried salted fish is significant in some countries. This is understandable because dried salted fish is the only stable fish product that can be produced in the tropics at a minimum cost and low level of technology.

A small but significant proportion of the fish production in the region is now frozen for export to generate foreign exchange. As a result, shrimp and tuna are often unavailable or expensive in local markets.

Most of the canned fish available in Indonesian markets is imported; local production is very limited (e.g., 500 tonnes per year in Java).

There are eight canneries in Vietnam, four of which produce 200 000 cans of mackerel, tuna, shrimp and crab a day.

In Bangladesh, fish are processed by sun-drying, salting and to a very limited extent smoking. The same processing methods are employed in Thailand except for a number of processing plants which export shrimp, tuna and mackerel. Fishmeal, fish sauce, salted and steamed fish, fish paste and dried fish are also manufactured by 560 processing plants. Approximately 70 percent of fish is used for animal consumption.

Sri Lankans prefer fresh to processed fish but a portion of the marine catch and some freshwater fish are dried particularly in the more remote areas. Small quantities of crustaceans and tuna are canned or frozen by the Ceylon Fisheries Corporation mainly for export.

FISH HANDLING AND MARKETING

Handling

As in most developing countries, the handling and transportation of fish is relatively crude and primitive. Little ice is used and fish are handled with minimal consideration for sanitation. In areas where ice has been introduced, its shortages and the high cost often prevent proper icing and the amount applied is usually a small fraction of the recommended ratio of 1:1. Poor handling methods are compounded by inadequate transportation facilities and many fish are already spoiled or in an advanced stage of deterioration before they reach the consumers.

Various governments have launched development projects aimed at improving the marketing and distribution facilities for fishery products. However, despite these programmes, fish landing facilities, and cold storage and fish distribution systems, in most countries are far from adequate. Table 5 shows the number of cold stores and ice plants in the different countries. It is estimated that the amount of ice produced is less than 0.25 kg per kg of fish landed.

Ice plants and cold stores

Ice is a scarce and expensive commodity in the region and storage facilities are inadequate to meet local demand. Consequently, spoilage is considerable and low grade fish are sold at very low prices to dried fish producers.

In Malaysia, the average amount of ice used per pound of fish is from 3 to 4 pounds and the price ranges from \$27.50 to \$33.00 per tonne, which is considered expensive compared to other fish producing areas in the world.

Table 5

Infrastructure

	BANGLADESH	BURMA	HONG KONG	INDONESIA	MALAYSIA
I. ICE PLANTS					
a. Number	12			22	162
b. Capacity (t/day)	400				4158
c. Fish to ice ratio	5:1				3:1
	Ice shortage amounts to 500 t daily during the height of the fishing season.	There is a shortage of 30 t of ice per day except during the months of June & July when production of fish is small.		Ice shortage during the milkfish harvesting season (June-July) causes the price of ice to increase by 10-15 percent.	
II. TRANSPORTATION	Insulated fish carriers are used mainly in carrying fish for BFDL and the cooperatives.			Transportation is a perennial problem in production areas where roads are in bad condition.	Transportation facilities are inadequate in most of the production centres

The relatively high prices are due to oligopolistic or monopolistic practices among the ice manufacturers. In the east coast of Peninsular Malaysia ice production is actually controlled by only two producers, the Cold Storage Malaysia Ltd. and the Fisherman's Cooperative Union; of the daily ice supply of 643 tonnes, they account for almost 524 tonnes.

Flake ice plants with a daily production capacity of 25 tonnes were constructed by the Fisheries Division at jetty sites in Kuala Besut and Kuala Trengganu and ice is expected to be sold at M.\$25.00 per tonne with free delivery on board.

Cold storage facilities are either absent or insufficient. They are used not only for fish but also for other products such as meat, fruit, etc.

In Thailand there are 140 ice plants with an aggregate annual production of 1.68 million tonnes. There are also 25 freezer/cold store units with a total capacity of 10 000 tonnes. An ADB-financed Development Project is expected to construct 5 additional refrigeration complexes with an annual gross ice production capacity of 134 000 tonnes and a total storage capacity of 1 000 tonnes. However, the combined capacity of these facilities is not adequate to meet the needs of the fishing industry.

There are 12 ice plants in Bangladesh with a total daily capacity of 400 tonnes. This falls short of the daily demand for ice, especially at the height of the fishing season when shortages amount to 500 tonnes daily.

Ice shortages occur in Indonesia during the milkfish season, from June to July, causing the price of ice to increase by 10-15 percent. Prices vary from Rp. 6 000 (U.S.\$14.45) to Rp. 12 000 (U.S.\$ 28.90) per tonne. In Central Kalimantan prices are as high as Rp. 30 000 (U.S.\$ 72.75) per tonne. Recently, the Indonesian Government has taken direct control of the distribution of ice; this eliminates the middlemen and keeps the price at a maximum of Rp. 7 500 per tonne.

In 1973 there were 22 cold storage plants in Indonesia with a capacity of 345 tonnes; 5 were in Sumatra (capacity of 55 tonnes), 12 were in Java (115 tonnes), Kalimantan had 3 (150 tonnes) and Sulawesi had 2 (with a capacity of 25 tonnes). At present, there are 51 cold storage companies operating in Indonesia with a total capacity of 12 405 tonnes per month.

As early as 1963 there were 273 ice plants in the Philippines with a combined capacity of 4 870 tonnes per day, of which 15-50 percent channelled their ice to the fishing industry. However, in remote areas, ice-making facilities are still inadequate.

The lack of adequate refrigeration and storage facilities seems to be the most pressing problem in the Philippines. There were only 6 government-owned ice plants with an overall capacity of 43 tonnes, but 11 more were constructed in 1970 in various strategic fishing centres.

Cold storage facilities in Vietnam, which are located at Rach Gia, Vung Tau and Saigon, have a total storage capacity of 4 350 tonnes; only 50-70 percent of the cold stores and 20 percent of the chilling facilities are in use at any one time. For chilling, they charge VN. dong^{1/} 0.35 per kg per day plus a handling fee of VN. dong 3.50 and the charge for frozen products is VN. dong 0.50 per kg per day plus VN. dong 6.50 for handling. A number of block ice plants operate in Rach Gia and Vung Tau with a production capacity of approximately 300 and 400 tonnes per day but these plants are not fully utilized even during the peak of the fishing season. Furthermore, demand for ice has declined due to increased prices caused by the fuel shortage.

1/ VN. dong 2.88 = U.S.\$ 1.00

Transportation

There are very few insulated or refrigerated trucks for fish distribution. Poor road conditions and the lack of ice also hinder distribution. While efforts are in hand to correct this situation, it would appear that for the next 10 years inefficient handling and distribution will be a common problem in the IPFC region.

Existing means of transportation are inadequate. Fish are transported by carts, bicycles, open lorries, trucks and trains which are generally not insulated.

On the east coast of West Malaysia, transportation is not a problem because private services, which are efficient and reasonably priced, are available. However, in various production centres, transportation facilities are either inadequate or irregular. Fish products packed in wooden boxes of 100 to 300 pounds capacity are transported in open trucks with only canvas tarpaulins to cover the cargo. Fish, transported over long distances using this method, often need re-icing.

Typical modes of transport in Indonesia are sea-going vessels, trains and trucks. Regularity and cost of transportation is dependent on the existing conditions; in Java, where roads are generally good, transportation is satisfactory but in areas where roads are bad, transportation is a perennial problem.

In Bangladesh, fish is usually transported on buses, boats and trains. Insulated fish carriers are used to carry fish for the Fisheries Development Corporation.

In the Philippines, fish is transported by fishing boats and fish carriers and by insulated trucks and jeeps. From Southern Luzon, fish is also brought to Manila by train in boxes lined with ice and banana leaves.

The need for insulated fish transport systems is also apparent in Thailand, Vietnam and Sri Lanka. There are a few insulated trucks in Vietnam, owned by shrimp-freezing companies; a small number of insulated trucks are also used in transporting fish in Thailand.

Marketing

Despite the diversity of culture in the IPFC region, the pattern of marketing seems to have many similarities. Fish products are collected by traders who transport and distribute to the retailers; products may change ownership as many as 5 to 9 times before they reach the final consumer.

DISTRIBUTION CHANNELS AND TRADE PRACTICES

Middlemen play an important role in fish marketing. The dependence on middlemen can be attributed to such factors as: distance between the production areas and the consuming centres; lack of contacts, transport and expertise in marketing; indebtedness, and the relatively small individual catch. Transactions between fishermen and the middlemen are generally on outright sale, consignment basis or by auction. Sale by auction is common in Thailand, Bangladesh, Indonesia, the Philippines and Sri Lanka.

In Sri Lanka two marketing systems are used, haggling and auctioning, depending on the contract that exists between the fishermen and the agent; auctioning is preferred since each man obtains a fair share. Haggling is a direct competition between the buyer and the seller.

Fishermen in Bangladesh sell their catch to fish brokers who then sell to other brokers by auction or send the fish direct to wholesale markets. The same method is practised in Thailand. In both cases, fishermen are forced to sell at low prices which are set by the fish brokers. They are also obliged to sell all their catch to their creditors.

Table 6

Foreign trade ('000 t)

	HONG KONG	INDONESIA	KAMPUCHEA	MALAYSIA	PHILIPPINES	SINGAPORE	THAILAND	VIETNAM
I. IMPORT								
1970	61.1	844.0	0.0	80.9	62.8	111.8	14.2	
1971	73.0	864.0		68.5	69.0	120.1	15.5	16.2
1972	73.9	918.0		76.5	64.3	122.8	18.2	
1973	81.6	1 057.0			41.3	132.0	20.0	
1974	78.9	1 075.0				123.5		
II. EXPORT								
1970	8.2	12.1		105.0	2.3	26.5	44.1	
1971	9.2	22.5	3.2	107.3	6.0	29.7	54.5	
1972	10.0	32.1		114.6	9.7	28.9	81.3	
1973	14.2	41.0		129.2	14.3	26.5	105.2	
1974	15.8	312.0		111.0	20.0	25.1		
III. BALANCE OF TRADE								
1970	-52.9	-839.1		24.1	-60.5	-85.3	29.9	
1971	-63.8	-841.5	3.2	38.8	-63.0	-90.4	39.0	-16.1
1972	-63.9	-886.0		38.1	-54.6	-93.9	63.1	
1973	-67.4	-1 016.0			-27.0	-105.5	85.2	
1974	-63.1	-763.0				-98.5		

In order to benefit the fishermen, the fisheries cooperative in Bangladesh has tried to link production with marketing. Furthermore, the Bangladesh Fisheries Corporation has been establishing marketing facilities at different points along the coastal area to promote marketing and ensure reasonable prices for the fishermen.

In Thailand, fish agents charge 6 percent commission plus fees for transport, freight and ice. Indebted fishermen also have to leave 5 percent of the total value of their catch with the agents as a deposit.

The Central Fisheries Cooperative System of Thailand has extended loans to members at 12 percent interest per annum; profits gained by the cooperative are shared among the members.

In Malaysia, transactions between fishermen and middlemen are on an outright sale-of-consignment basis. The consignor sells the fish on behalf of the consignee for a commission varying from 5 to 10 percent of the gross sales; generally, the consignee quotes a net price. Repayment can be made any time depending on the mutual agreement of the two parties. Where loans have been extended, deductions are made from the sales value.

Middlemen control the fish trade in Vietnam; they buy and sell fish and they lend money with no collateral. Fishermen have no choice but to accept the terms determined by the fish traders.

In some coastal areas of the Philippines, such as Palawan, fishermen are hired by brokers on a 10-month contract. Advance payment is given to these fishermen and they are paid during the period of the contract by deduction from fish sales. The fishermen are obliged to sell their catch to the contracting operators who dictate the price of the fish.

Another common practice is that boatowners hire fishermen to operate the vessels. The fishermen sell their catch to the boatowner; operational expenses are deducted and the remainder is shared, a quarter to the operator and three quarters to the fishermen.

A chain of collectors, subcollectors, wholesalers and fish peddlers dominate the fish market in Indonesia. A small group of influential traders control a whole region; they arrange licenses and transportation of fish to the market and they also lend money to fishermen. The marketing of fish involves the fisherman or fish farmer, middlemen, retailers and finally, consumers.

Depending on the value of the products, the price differential between that paid to the producer and that paid by the consumer ranges from 100 percent to about 250 percent. A very important feature of the marketing system is that traders provide some form of financing to the producers. This financing is given primarily to ensure a supply of fish and not necessarily to secure a price advantage. In all countries there are very few organizations which are engaged in production, distribution and processing.

FOREIGN TRADE

Fish exports are rapidly gaining importance because of the foreign exchange generated. Indonesia, the Philippines and Sri Lanka run a trade deficit in fish while Thailand and Malaysia are exporters of fish and fish products.

Export of fish from the Philippines in 1970 was 2, 300 tonnes, representing a total value of about U.S.\$ 2.5 million. In 1974 this had risen to 14 300 tonnes, valued at U.S.\$ 19.84 million. Despite this, fish imports were 41 300 tonnes in 1973, assessed at U.S.\$ 20.13 million.

Indonesia exported 312 000 tonnes of fish in 1974, worth about U.S.\$ 74.14 million. For the same year, the country imported 1 075 000 tonnes, valued at U.S.\$ 1 380.12 million.

In 1963-64, in Bangladesh, about U.S.\$ 5.25 million worth of fish products were exported. However, from 1965, exports declined but more recently an upward trend was observed in both the quantity and value of the fish exports.

In Malaysia, total exports in 1972 were 111 600 tonnes while total imports were 76 500 tonnes (value U.S.\$ 56 771 000).

Thailand's export increased from 44 100 tonnes in 1970 (valued at U.S.\$ 17 654 000) to 105 200 tonnes in 1973, a growth of 138 percent. Imports, on the other hand, are also increasing. In 1970, imports were 14 200 tonnes but increased to 20 400 tonnes in 1973.

SUMMARY AND RECOMMENDATIONS

Undoubtedly, the fishing industry is very important to the economic and social well-being of the people in the IPFC region. The exploitation of fishery resources is the most viable and effective way of increasing the availability of animal protein in a short time. Thus, all the governments, through the support of the international agencies or on their own account, have launched various fishery development programmes.

To date, the introduction of modern gear and technology has resulted in the rich resources of the sea being used to provide fish for human consumption as well as for animal feeds. However, recent experiences have shown that wanton exploitation of the resources, without considering ecological factors, can lead to disastrous results. The overexploitation of demersal resources in certain seas and the consequent decline in the marine fish landings provides a stark example.

Recent developments on the International Law of the Sea and the increasing cost of oil have resulted in a levelling of production of internationally traded fishery commodities. However, demand continues to increase due to the increasing population. This provides a positive incentive for fish producers to expand production of exportable species.

Techniques for breeding certain freshwater species such as shrimps, catfish and carp have been developed and these species can be exploited for efficient food production.

In addition to the massive fisheries development projects, other economic and developmental projects must also be supported. The construction of fish landing terminals and cold storage facilities are good incentives to the fisherman but they would be of little use without an efficient transport system.

The overexploitation of the coastal areas can be minimized by providing fishermen with sufficient credit to modernize their craft. This will also enable better exploitation of the off-shore resources. Credit must be available not only for the purchase of capital goods but also in providing operating expenses so that the fishermen will not be tied to the traders and will be able to market their produce at more favourable terms.

As more fish is produced, the new species caught will meet consumer resistance. However, experience in Thailand has shown that a systematic educational campaign can influence the consumer to accept unusual fish species.

While an increase in fish production is expected, efforts must also be exerted to utilize most of the fish for direct human consumption instead of converting it into animal feed. Thus, priority for research and development must be given to the utilization of by-catch of the trawl fishing industry.

The people concerned with the handling and marketing of fish must be educated and more economical handling of fish so that they can reach the consumer in good quality and at lower cost. Training on production, distribution and marketing must not be confined to technical personnel but must also be directed toward lay people.

REFERENCES

- Aoyama, T., The demersal fish stocks and fisheries of the South China Sea. Rom, FAO, SCS/DEV/73/3:80 p.
1973
- Bersamin, S.V., F.R. Gonzalez and R.R. Banania, Survey of fresh fish handling and distribution in the 1964 Philippines. *Proc. IPFC*, 11(3):193-216
- Engvall, L.O., E. van Noort and C. Larson, Republic of Vietnam. Pre-feasibility study of a purse seine fishery. Report prepared for the Off-shore Fishery Development Project. Rome, FAO, F1:DP/RVN/67/503/2:30. 1974
- FAO, Yearbook of fishery statistics, 1974
1975
- , Development potential of selected fishery products in the regional member countries of the Asian
1977 Development Bank. Manila, South China Sea Fisheries Development and Coordinating Programme, SCS/DEV/76/11:108 p.
- , Development potential of selected fishery products in the regional member countries of the Asian
1977a Development Bank. Fishery country profiles. Manila, South China Sea Fisheries Development and Coordinating Programme, SCS/DEV/76/11 APP.I:173 p.
- Folsom, W.B. and J.J. Reilly, Fisheries of Indonesia, 1972 Foreign Fish. Leaf 1., (74/4):29 p.
1974
- IPFC (Indo-Pacific Fisheries Council), Country statement. Indonesia. Bangkok, FAO Regional Office for Asia and
1974 the Far East, IPFC/74/21F:15 p.
- , Country statement. Malaysia. Bangkok, FAO Regional Office for Asia and the Far East, IPFC/7421G:
1974a 20 p.
- , Country statement. Sri Lanka. Bangkok, FAO Regional Office for Asia and the Far East, IPFC/74/
1974b 21A:18 p.
- Japan International Development Corporation, Report of shrimp culture development project. Tokyo, Japan
1977 International Development Corporation, 50 p.
- Lagler, K., First Interim report, Second Fisheries development project of Bangladesh. Manila, International
1972 Agro-Fisheries System
- Ling, S., Status, potential and development of coastal aquaculture in the countries bordering the South China
1973 Sea. Rome, FAO, SCS/DEV/73/5:51 p.
- Malaysia, Fisheries Development Project, Feasibility study. East Coast of Peninsular Malaysia Fisheries Develop-
1977 ment Project Report, 1:5-7
- Menasveta, D. *et al.*, Pelagic Fishery resources of the South China Sea and the prospects of their development.
1973 Rome, FAO, SCS/DEV/73/6:68 p.
- Prayitno, A.R., Fish marketing and the prospect in Indonesia. Jakarta, Indonesia, Department of Agriculture
1974
- Rabanal, H.R., The potentials of aquaculture development in the Indo-Pacific region. Paper presented to the IPFC
1974 16th Session, Jakarta, Indonesia, 30 Oct.-8 Nov. 1974, IPFC/74/Inf. 18:34 p.

- Ruckes, E., Fish utilization, marketing and trade in countries bordering the South China Sea—status and programme proposals. Rome, FAO SCS/DEV/73/8:33 p.
1973
- Sachinanthan, K., The rural fish trade in Sri Lanka. Paper presented to the 2nd meeting IPFC working party on fish technology, Colombo, 15 p.
1976
- Stirrat, R.L., Fish to market: traders in rural Sri Lanka. *Asia Rev.*, 7(3):16-8
1974
- Tussing, A.R., Fishery development perspective. Sub-region 5: South China Sea, *Proc. IPFC*, 16(3):55-73
1974
- UNDP, Republic of VietNam. Background paper for the preparation of UNDP country programme. Saigon, 1972 UNDP, 242 p.

SESSION

II

SESSION II

FRESH FISH HANDLING AND DISTRIBUTION

CONTENTS

POST HARVEST HANDLING OF LIVE MARINE FISH IN HONG KONG by Albert Leung	128
TEMPERATURE AND SEAFOOD SPOILAGE by June Olley, H. Bin Daud and T.A. McMeekin	136
A PRELIMINARY STUDY ON THE QUALITY OF FRESH FISH TRANSPORTED BY CARRIER BOATS ALONG THE BOMBAY COAST by A.P. Valsan and P. Vasudeva Prabhu	146
THE FEEDING OF 'WILD' EELS: A PRELIMINARY INVESTIGATION by J. Sumner and G. Hopkirk	151
PROBLEMS OF <i>SALMONELLA</i> IN FROGLEGS by Posma R. Tambunan and Endang Sri Heruwati	154
AN INVESTIGATION INTO THE UTILIZATION OF THE TROPICAL RED SNAPPER (<i>LUTIANUS BOHAR</i>) by A. Hoffman and S. Vidot	157
QUALITY CHANGES IN FISH FROM THE SOUTH CHINA SEA: ICED STORAGE OF CHUB MACKEREL, GROUPER AND FUSILIER by R.G. Poulter, Linda Nicolaides and D.A. Hector	169
A REFRIGERATED SEA WATER PLANT FOR SMALL BOATS by N.S. Boyd, N.D. Wilson and A. Edley	186
HANDLING AND CHILLING METHODS AND THEIR EFFECT ON QUALITY by N.S. Boyd and N.D.C. Wilson	193
ICED STORAGE OF MALAYSIAN FISH by A. Kamari and Z. Merican	197
FLAVOUR CHANGES DURING THE STORAGE OF MILKFISH (<i>CHANOS CHANOS</i> <i>FORSKAL</i>) IN ICE AND AT -12.2°C by C.G. Beza and E.C. Sison	204
THE PROBLEM OF BURNT TUNA IN THE HAWAIIAN FISHERY by Jean I. Cramer, Richard S. Shomura and Heeny S.H. Yuan	213
A PRELIMINARY STUDY OF THE MICROBIOLOGY OF ICED CHUB MACKEREL IN THAILAND by B. Saisithi and K. Tipkong	224
USE OF THE TORRYMETER TO ASSESS QUALITY OF MALAYSIAN FISH by Z. Merican, A. Kamari and R. Abdullah	229

POST-HARVEST HANDLING OF LIVE MARINE FISH IN HONG KONG

by

Albert Leung
Agriculture and Fisheries Department
Hong Kong

Abstract

In 1976 the annual production of live marine fish in Hong Kong was estimated at 2,070 tonnes and valued at U.S.\$ 10.62 million. Three quarters of these fish are produced by the capture fishery sector and the remainder by the culture fishery sector. The capture fishery sector consists basically of longliners and gill-netters and exploits fish from the accessible coral reef areas. The culture fishery sector produces live fish mostly by cage culture. The pattern of post-harvest handling and marketing is similar for both capture and culture fish although the former involves more elaborate handling procedures. At present, the mortality due to post-harvest handling of the capture fish is substantial. Improvement of the fishing methods, the design of vessels and, in particular, the seawater circulation system used on board such vessels can reduce handling and transport mortalities. The condition of the seawater in which fish are kept alive for wholesaling should be favourable to the survival of the fish. The possible use of a tranquillizer to avoid excessive injury to the fish during handling should also be studied.

INTRODUCTION

Live marine fish marketed in Hong Kong are produced by both the capture and culture fishery sectors. Over the past decade, increased consumer demand for live fish, especially among the Chinese population, has elicited the rapid growth of this industry. Thus in 1976 an estimated 2 070 tonnes of fish were marketed earning a total income of U.S.\$ 10.62 million (Cheng, 1977). The capture fishery supplied by far the greater proportion of fish (1 496 tonnes), although these commanded a lower average price (U.S.\$ 4 640/tonne) than their culture counterparts (around U.S.\$ 6 400/tonne). The economic viability of this industry is as dependent on the availability of the resource as on efficient methods of post-harvest handling. This paper examines the latter aspect and suggests means of improvement to reduce the mortalities which occur at present.

THE CAPTURE FISHERY

Captured live marine fish come predominantly from coral reef areas. Fishing grounds of major importance include the Pratas Reef, the Taya Islands, the Paracel Reefs and the McClesfield Bank (Fig. 1). Other more distant grounds are also fished. Longliners and gill-netters fish in these grounds and the gears employed include handlines, longlines, gill-nets, purse seines and traps. Each vessel is equipped with a number of live-fish holding tanks which are usually situated forward. An average-sized tank might measure 1.0 x 1.4 x 1.4 (depth) m. The tanks are individually sealed from each other and are provided with small holes in the bottom to enable circulatory exchange of water with the sea. The tanks may also have motor-driven aerators to provide adequate aeration.

Each trip varies from 10 days to over a month depending on the catch, the weather and the distance to the fishing ground. The actual time spent fishing is, however, usually between 7 and 10 days. The peak season for the coral reef fishery is between February and May when the northeast monsoon has subsided and before the southwest monsoon sets in. The Pratas Reef is the most commonly fished ground during these months owing to its relatively rich resource and proximity to Hong Kong. It has been estimated that over 150 vessels are engaged in this fishery during the peak season. However, when the southwest monsoon is at full strength, which affects the operation of the smaller vessels, this number declines. A proportion of the vessels also switch to grounds in the neighbourhood of the Taya Islands.



Fig. 1 – A map showing the grounds exploited by the live marine fish fishing fleet of Hong Kong.

Post-harvest handling

The live fish are kept in floating cages which are cylindrical in shape and made of nylon netting, supported by two circular metal rings each 1.0 m in diameter. The catch is sorted by size and transferred into the vessel's holding tanks. During transit, the fish are generally not fed because of congestion in the tank and the unsettled physiological state of the fish. On arrival at the home port, the fish are sorted into species, weighed and sold to wholesalers at mutually agreed prices. Prices for different species may vary by a wide margin as a result of differences in consumer demand. The price of the same species may also vary depending on the condition and seasonality. A list of the average wholesale prices of over 50 common species, together with their sizes as recorded in recent sampling surveys at various landing sites, is given in Table 1.

Table 1

Common live marine fish species landed in Hong Kong:
their average size and wholesale price (August 1977)

Species	Common Name	Size (cm)	Price (U.S.\$/Kg)
<i>Cromileptes altivelies</i>	High finned grouper	40	35.56
<i>Plectropona leopardus</i>	Leopard coral trout	60	7.11
<i>P. maculatum</i>	Leopard coral trout	60	7.11
<i>Epinenphelus megachir</i>	Long finned grouper	25	5.69
<i>E. medurensis</i>	Long finned grouper	25	5.69
<i>E. Kohlori</i>	Kohlori's grouper	40	4.99
<i>E. fucoguttatus</i>	Flower cod	80	8.18
<i>E. awoara</i>	Yellow grouper	30	6.40
<i>E. akaara</i>	Red grouper	25	16.34
<i>E. fasciatus</i>	Black-tipped red grouper	20	6.40
<i>E. tauvina</i>	Green grouper	100	8.18
<i>E. fasciomaculatus</i>	Rock grouper	18	6.40
<i>Cephalopholis argus</i>	Peacock rock cod	18	7.11
<i>C. urodelus</i>	Flag-tailed grouper	25	6.40
<i>Variola louti</i>	Lunnar-tailed grouper	30	8.18
<i>Psammoperca waigiensis</i>	Red-eyed perch	35	13.51
<i>Lutjanus gibbus</i>	Humpback red snapper	38	13.51
<i>L. bohar</i>	Two-spotted snapper	60	2.13
<i>L. vitta</i>	One-banded snapper	25	9.25
<i>L. argentimaculatus</i>	Mangrove snapper	70	10.67
<i>L. kasmira</i>	Yellow snapper	18	8.89
<i>L. russelli</i>	Russell's snapper	30	10.67
<i>L. rivulatus</i>	White-blotched snapper	45	24.89
<i>Macolor niger</i>	Black and white snapper	45	2.84
<i>Lethrinus miniatus</i>	Long-nosed emperor	45	3.91
<i>L. variegatus</i>	Variegated emperor	25	3.91
<i>L. nebulosus</i>	Sprangled emperor	25	3.91
<i>L. ornatus</i>	Yellow-striped emperor	25	3.91
<i>Plectorhycus nigrus</i>	Black sweetlip	55	5.33
<i>P. flavomaculatus</i>	Orange-spotted sweetlip	55	5.33
<i>P. chaetodonoides</i>	Barliquium sweetlip	55	5.33
<i>Hemigymnus melapterus</i>	Thick-lipped wrasse	30	8.89
<i>P. curvieri</i>	Banded sweetlip	55	5.33

<i>Scarus bicolor</i>		30	10.67
<i>S. microrhinos</i>	Blunt-headed parrot fish	35	2.13
<i>S. jordani</i>	Jordan's parrot fish	30	10.67
<i>S. ghobban</i>	Blue-barred parrot fish	30	14.22
<i>S. fasciatus</i>	Tattooed parrot fish	35	10.67
<i>S. frenatus</i>	Yellow-finned parrot fish	40	10.67
<i>S. limbatus</i>		35	16.00
<i>S. janthochir</i>		50	10.67
<i>S. longiceps</i>	Long-nosed parrot fish	25	10.67
<i>S. erythron</i>	Red-toothed parrot fish	25	10.67
<i>Cheilinus undulatus</i>	Double-headed wrasse	45	21.34
<i>C. anchorage</i>	Yellow cheeked tusk fish	30	8.89
<i>C. fasciatus</i>	Scarlet-breasted wrasse	25	4.98
<i>Choerodon schoenleinii</i>	Black-spotted tusk fish	45	23.11
<i>Kyphonsus lembus</i>	Large-tailed drummer	40	2.84
<i>Siganus sutor</i>	Gold-spotted rabbit fish	18	4.27
<i>S. fuscescens</i>	Fuscous rabbit fish	15	4.27
<i>Parupeneus trifasciatus</i>	Three-banded goatfish	20	4.98
<i>Pseudupeneus barbarinus</i>	Yellow goatfish	25	4.98
<i>Upeneus cyclostomus</i>	Yellow goatfish	25	4.98
<i>Goniistius zonatus</i>	Flagfish	25	11.38
<i>Holocentrus ruber</i>	Yellow striped soldier fish	20	2.40

The fish which are sold to wholesalers are kept in cages and barges; the barges have circulatory and aerating systems similar to those installed on the fishing vessels. The fish are normally fed minced, trash fish. When orders for live fish arrive from the retailers such as restaurants and markets, the required species are loaded and delivered on lorries which are fitted with aerated tanks. During the entire process the handling of the fish is reduced to a minimum to avoid excessive injury. At the retail destination, the fish are transferred to aquaria until required for human consumption. Fish weighing over 300 g are generally considered marketable. Smaller fish, especially some groupers and snappers, are sometimes sold as fry to farmers for fattening and culture. In addition, a number of exotic species are often sought by aquarium fish dealers.

THE CULTURE FISHERY

Cultured live marine fish are mostly produced by cage-culture methods. The largest number of culture units are found in Sok Kwu Wan, Ma Nam Wat, Po Toi O and Tap Mun. Other cage-culture sites are shown in Fig. 2. In 1976, a total of 974 culture units and 9 impoundments covering a total area of 23.43 ha were recorded (Cheung, 1976). The fish are cultured in cages made of wire or nylon netting and suspended from wooden drafts. Fish of the same species and size are generally kept inside the same cage. The cages are usually not served by aerators as circulation resulting from tidal movements is usually adequate.

Post-harvest handling

The marketing of cultured marine fish is generally dependent on fish size and consumer demand. At harvest, fish are transferred by means of a scoop net from the culture cage to a carrier boat, equipped with holding tanks. In the case of impoundment culture, the fish are herded by means of a seine net and selected for sale. The carrier boat transports the fish to another location where they are weighed and sold to wholesalers. These fish are then handled through the same channels as for the captured species. A list of the most common 20 species cultured in Hong Kong is given in Table 2.

LIVE MARINE FISH

CULTURE SITES

- 1 Sha Tau Kok
- 2 Ap Chau
- 3 Kat O
- 4 Sai Lau Kong
- 5 Wong Wan
- 6 Tap Mun
- 7 Kau Lau Wan
- 8 Chek Keng
- 9 Yim Tin Tsai
- 10 Ha Hang
- 11 Tai Mei Tuk
- 12 Loo Foo Fat
- 13 Wu Kai Sha
- 14 Ting Kok
- 15 Po Toi O
- 16 Leung Shuen Wan
- 17 Kau Sai
- 18 Tai Tau Chau
- 19 Sai Kung
- 20 Ma Nam Wat
- 21 Pak Sha Wan
- 22 Hang Hau
- 23 Tin Ha Wan
- 27 Cheung Chau
- 28 Deep Water Bay
- 29 Ma Wan
- 30 Mu Wo
- 31 Peng Chau
- 32 Po Toi
- 33 Sok Kwu Wan
- 34 Shap Long
- 36 Tai Tam
- 37 Tsing Yi
- 38 Tung Chung

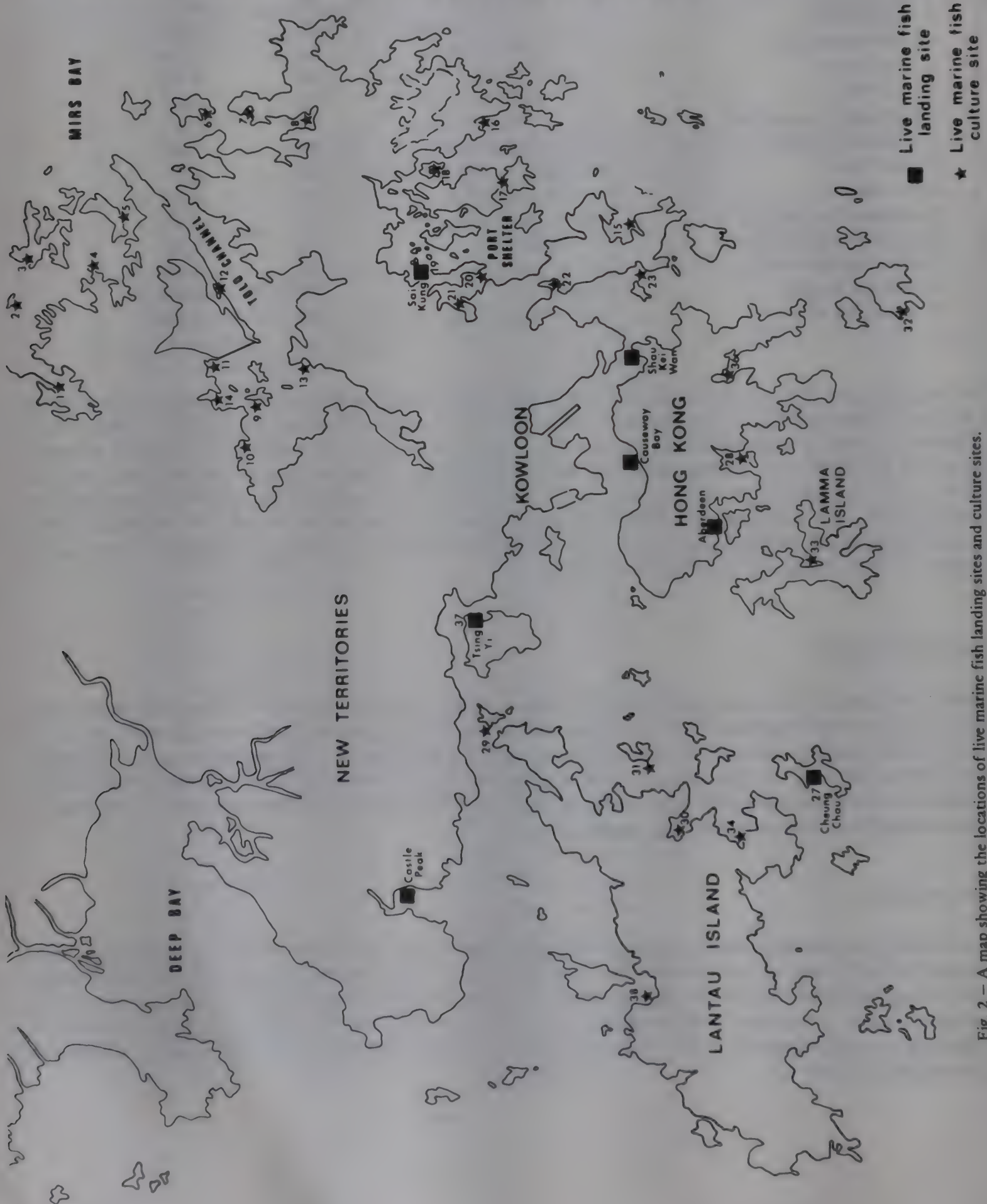


Fig. 2 — A map showing the locations of live marine fish landing sites and culture sites.

Table 2

Common species cultured in Hong Kong:
their average market size and wholesale price (October 1976)^{a/}

Species	Common name	Size (cm)	Price (U.S.\$/kg)
<i>Spinephelus akaar</i>	Red grouper	35	15.91
<i>E. brunnus</i>	Mud grouper	40	6.34
<i>E. awoara</i>	Yellow grouper	25	6.93
<i>E. tauvina</i>	Green grouper	50	12.21
<i>Cromileptes altivelis</i>	High-finned grouper	35	30.21
<i>Lutjanus sanguineus</i>	Red snapper	30	5.89
<i>L. russelli</i>	Russell's snapper	25	6.67
<i>L. lineolatus</i>	Banded red snapper	20	9.10
<i>L. johni</i>	John's snapper	20	11.31
<i>L. argentimaculatus</i>	Mangrove snapper	30	11.97
<i>Chrysophrus major</i>	Red pargo	20	3.99
<i>Rhabdsarga sarba</i>	Gold-lined seabream	18	6.20
<i>Mylio latus</i>	Yellow-finned seabream	15	7.54
<i>M. berda</i>	White seabream	18	7.49
<i>Pomadasys hasta</i>	Head grunt	10	3.16
<i>Plectorhynchus spp.</i>	Sweetlips	30	8.35
<i>Siganus spp.</i>	Rabbit fish	15	9.30
<i>Lates calcarifer</i>	Sea perch	25	4.74
<i>Therapon jarbua</i>	Tiger fish	18	3.55
<i>M. macrocephalus</i>	Black seabream	18	8.55

DISCUSSION ON MORTALITY FACTORS AND MEANS OF IMPROVEMENT

At present, mortality due to post-harvest handling of captured live fish is substantial; over 50 percent of the fish caught do not survive. Recent interviews have shown that the most significant factor is injury, inflicted by the fishing gear. The correct choice of gear is therefore of outmost importance. For example, although purse seining and trapping cause the least injury and are therefore preferred, the number of species captured is limited; traps are also relatively inefficient. Handling is not uncommon but is labour-intensive and longlines are generally efficient provided the fish are not hooked for too long. Gill-nets inflict the most damage and fish caught by this method suffer the highest mortality.

Excessive agitation of the water within the holding tanks during rough weather is another cause of mortality. Better stability of the boat in rough weather and improvements in the circulating system on board will help to reduce such losses. A suggestion for an improved circulatory system is shown in Fig. 3. In this system, water is pumped into the holding tank through reinforced rubber tubing and excess water is allowed to overflow through an L-shaped discharge pipe. The discharge pipe is designed to allow adjustment of the water level and the L-shape prevents most of the back-flow of water when the vessel pitches. When emptying the tank water can be pumped out simply by reversing the positions of the tubes used in the filling process. This circulatory system has two advantages. First, the volume of water inside the tank can be kept at any desired constant level to accommodate varying quantities of fish. Second, adequate aeration is provided through the spraying action of the inflowing water.

^{a/} Source, Cheung 1976

Massive fish mortalities have also been experienced by wholesalers who keep their fish near the landing sites. The landing sites in Aberdeen, Tsing Yi, Causeway Bay and Shau Kei Wan are all located within the typhoon shelter areas where pollution from urban and industrial discharges is considerable. The landing site in Castle Peak is exposed to the effects of the south-west monsoon as well as the waters of the Pearl River discharge which can cause a drastic reduction in salinity in that area. Therefore, a new location should be considered for the purpose of centralizing all live fish wholesaling activities. Ideally, this should be in the northeast sector of Hong Kong where hydrographic conditions are under the influence of oceanic currents favourable to the survival of marine fish species.

Mortality through post-harvest handling is much lower in cultured fish than in the capture fishery. This is possibly a result of the fish being acclimatized to environmental conditions in captivity. However, injury leading to mortality may still result during transit, especially from the producer to the wholesaler, when the fish tend to be excited and unsettled. While it is possible to use tranquillizers to reduce such injuries, this method cannot be recommended until their side effects are proved to be harmless. To the consumer, the vitality of the fish is as important as its general appearance.

REFERENCES

- Cheng, K.W.J., Statistics on fishery production, January-December, 1976. *AFD Econ. Market. Occas. Pap.*, 1977(6)
- Cheung, P., Preliminary results of the mariculture survey. Hong Kong, Agriculture and Fisheries Department 1976 (Unpubl. mimeo)

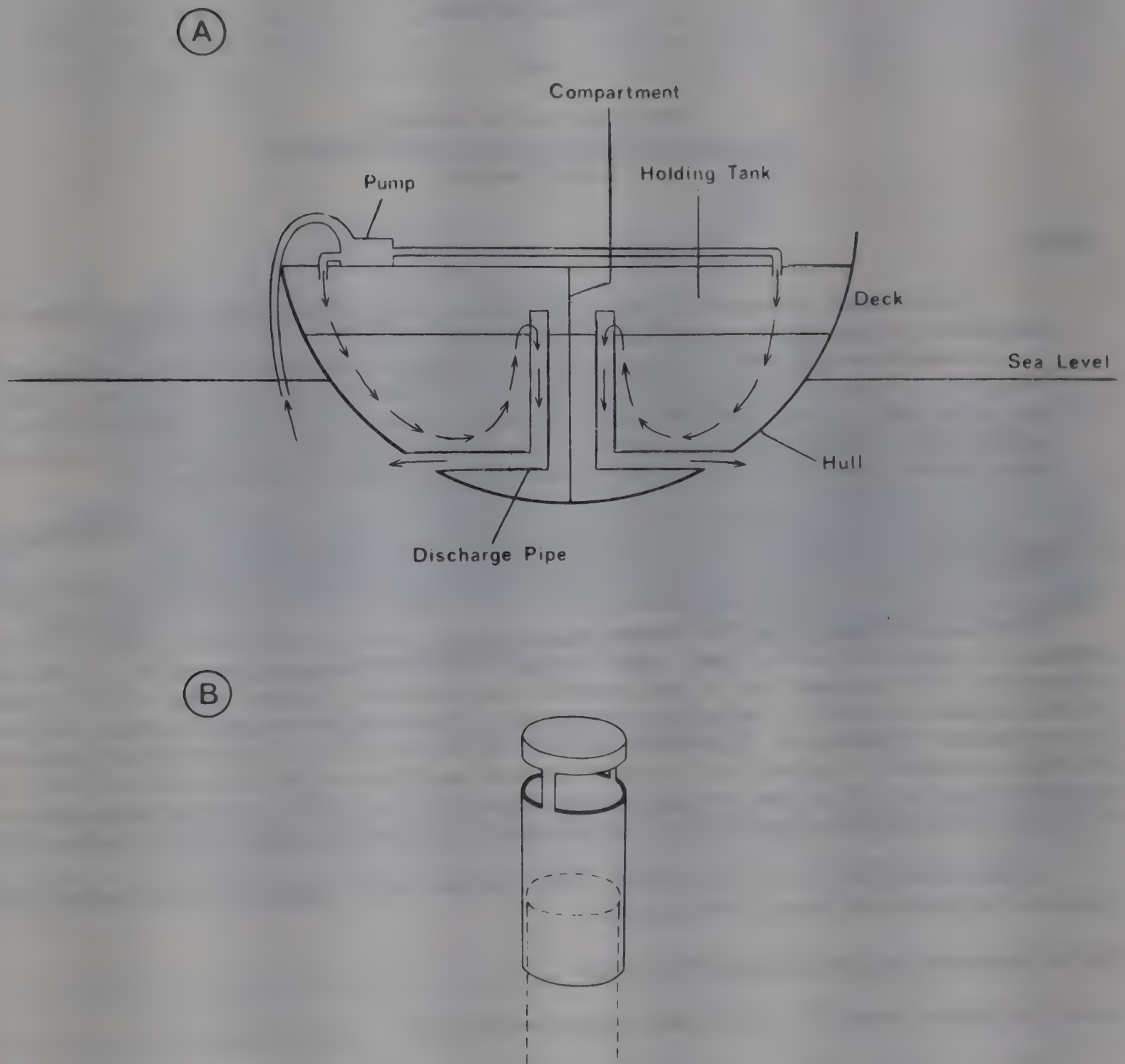


Fig. 3 — A : A schematic drawing of the improved circulatory system.
B : Detail drawing of the top of the discharge pipe.

TEMPERATURE AND SEAFOOD SPOILAGE

by

June Olley
CSIRO Tasmania Food Research Unit
Hobart, Tasmania

and

H. Bin Daud and T.A. McMeekin
Department of Agriculture, University of Tasmania
Hobart, Tasmania

Abstract

A plea is made for research workers to study the spoilage of their products at a minimum of two temperatures, so that relative spoilage curves can be determined.

A curve showing the rate of spoilage at different temperatures relative to the rate of spoilage at 0°C is being built up from data in the literature. This relative rate spoilage curve may be common to fish, meat and poultry and it is most important to know if it can be applied to tropical fish and shellfish. If this curve applies to tropical species, a rule of thumb would be available to gauge the effect of time and temperature on any species, providing that the storage life under optimum conditions in ice is known.

INTRODUCTION

At the second session of the IPFC Working Party on Fish Technology and Marketing (FAO, 1977) several proposals for cooperative activities were made. Amongst these were 'storage of tropical fish at intermediate temperatures'. Ice is expensive and in short supply in the Indo-Pacific fisheries region and it is, therefore, desirable to know the benefits of reducing the temperature of fish rather than bringing the whole catch down to the temperature of melting ice. Experiments could be carried out on all the species already marketed, or potentially marketable, in tropical zones. A simpler approach would be to study a few species of fish at several temperatures and see if the relative rate spoilage curve between 0°C and 25°C relative to the rate of spoilage at 0°C, built up for proteinaceous foods by Olley and Ratkowsky (1973a and b), applies to tropical species of fish.

At the Working Party in Sri Lanka (FAO, 1977) the first author suggested that cooperating institutes should use the Spencer and Baines (1964) equation:

Rate of spoilage at temp. $\theta^{\circ}\text{C}$ = Rate at 0°C (1 + $c\theta$)

where c is a constant, up to 8°C . This constant is approximately 0.25.

Unfortunately, 0° and θ° were not distinguished in the printed proceedings and, as this relationship only appears to hold up to about 8°C (Olley, 1976), it has been suggested that a relative rate spoilage chart should be provided for those concerned in fish transport and storage.

People tend to shrink from equations and we have been advised that fishermen, road and rail haulers, those concerned with air freight, and processors and retailers could more easily make themselves familiar with a chart of relative spoilage rates at different temperatures. The question is, can such a chart be drawn, even if it is only an approximation?

RATE OF SPOILAGE OF PROTEINACOUS FOODS AT TEMPERATURES BETWEEN 0°C AND 25°C COMPARED TO THAT AT 0°C

The Olley and Ratkowsky relative rate spoilage curve

Olley and Ratkowsky (1973b) derived a spoilage curve between 0°C and 25°C for proteinaceous food products relative to their spoilage rate at 0°C. Their curve was derived from seventy data sets (Olley and Ratkowsky, 1973a); eight of these were derived from work on meat, three on chicken and the remainder on fish. Their curve will be referred to as the O & R calculated curve. This curve has been built into the electronic circuitry of a temperature function integrator, patented in New Zealand and designed to simulate the spoilage of proteinaceous foods with time and temperature and to read out the equivalent time at 0°C on a digital display (see Fig. 1, cf, also Olley, 1976).

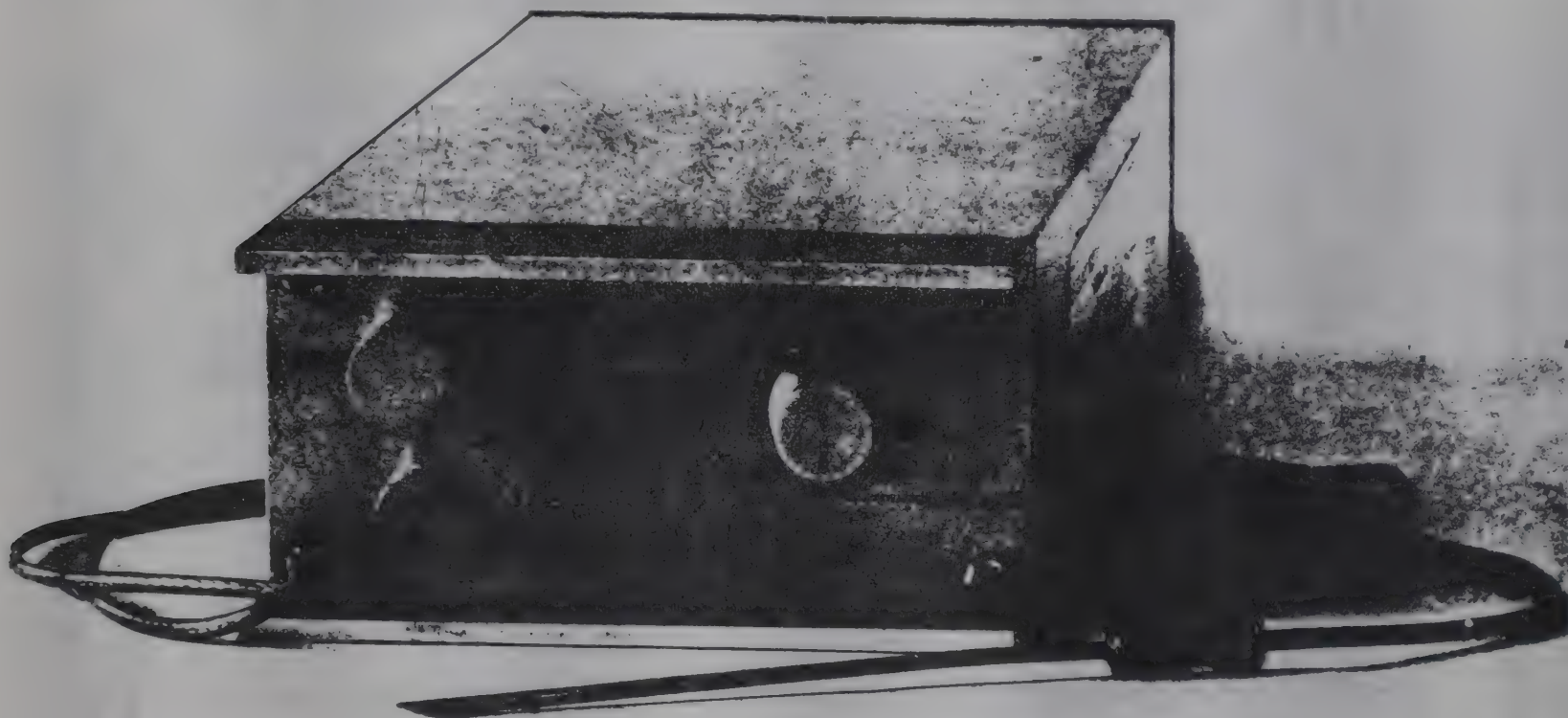


Fig. 1 — Temperature function integrator

Fig 2. shows the O & R calculated curve and some later results on steak and thawed chicken obtained in Northern Ireland. Chicken would appear to spoil relatively more rapidly between 15° and 20°C; at least more rapidly than cod (38 of the original data sets from which the O & R curve was derived were obtained from work on this species).

THE RELATIVE RATE OF SPOILAGE OF CHICKEN AS COMPARED TO THE RATE AT 0°C

Spoilage curves of Daud and McMeekin

Current work at the University of Tasmania has shown that the O & R calculated curve would have potential for predicting the spoilage of chicken up to 15°C. Whole carcasses, skin and muscle of chicken have been incubated at different temperatures, as have the main spoilage bacteria isolated from chicken skin, on nutrient broth and on individual amino acids. The systems are listed in Table 1 with a number code which is used in Fig. 3. This figure shows that there is a promising similarity in the relative rate spoilage curves.

Table 1
Application of the Arrhenius equation to chicken spoilage systems^{a/}

Model systems	Arrhenius equation			Degrees of freedom
	Code number	Apparent activation energies kcal/mole	Reaction rate and temperature r b/	
Spoilage by natural flora of:				
Chicken carcasses	1	18.7	-0.993	3
Breast skin macerate	2	15.1	-0.966	10
Leg skin macerate	3	15.5	-0.977	10
Breast muscle macerate	4	16.9	-0.991	14
Leg muscle macerate	5	17.6	-0.996	14
Growth in nutrient broth of:				
<i>Alteromonas putrefaciens</i>	6	20.1	-0.989	24
<i>Pseudomonas</i> Group I	7	19.9	-0.994	13
<i>Pseudomonas</i> Group II	8	21.2	-0.994	14
Bacterial utilization of:				
L-Arginine by a strain of <i>Pseudomonas</i> Group II ^{c/}	9	15.6	-0.975	11
L-Asparagine by a strain of <i>Pseudomonas</i> Group II ^{c/}	10	24.2	-0.996	5
L-Aspartic acid by a strain of <i>Pseudomonas</i> Group II ^{c/}	11	17.2	-0.993	6
L-Proline by a strain of <i>Pseudomonas</i> Group III	12	17.8	-0.986	7
L-Serine by a strain of <i>Pseudomonas</i> Group I	13	17.9	-0.999	8
L-Tyrosine by an enteric type	14	22.6	-0.999	7

a/ Data from H. Bin Daud, Honours Thesis, University of Tasmania (1978)

b/ Correlation coefficient r, all values significant at the 0.1% level

c/ Culture types were selected which would completely utilize the individual amino acid in 1-2 days at 22°C

The Arrhenius Law

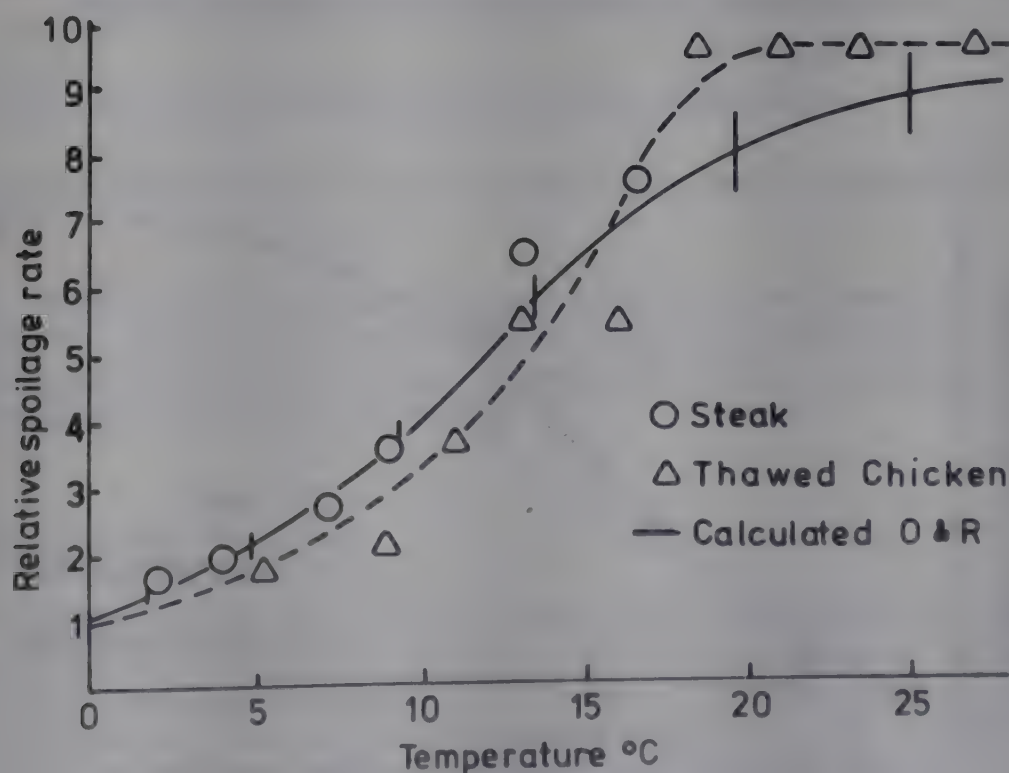
At the Sri Lanka meeting, the simple linear equation between spoilage and temperature up to 8°C was introduced because Olley felt that the more general Arrhenius Law was difficult for those with little mathematical training.

The Arrhenius Law states that the logarithm of the rate of reaction in a system is proportional to the reciprocal of the absolute temperature:

$$\log \text{ rate} \propto \left(\frac{1}{273 + \text{temperature in } ^\circ\text{C}} \right)$$

Those interested in this relationship should read the article "Unconventional Applications of the Arrhenius Law" by Laidler (1972). He describes how the rate of chirping of tree crickets, flashing of fire flies, rate of counting in humans of different body temperatures and creeping of ants are all influenced by temperature in a linear manner, if this equation is used. The slope of the line is called the Energy Barrier or apparent activation energy.

Despite the desire for simplicity here, the concept has been introduced because Fig. 3 clearly indicates that there was no linear relationship between rate of spoilage and temperature above 8°C; but Table 1 shows that the apparent activation energies of all the poultry systems for the relationship between the logarithm of the spoilage rate and absolute temperature were highly significant and of a similar order. The mean apparent activation energy of the 14 systems was 18.6 kcal/mole with a standard error of 0.725 kcal/mole. All the apparent activation energies were in the range 15-25 kcal/mole quoted by White, Handler and Smith (1973) as typical for the majority of ordinary chemical reaction, including catalytic ones. Morales (1947) showed that approximately 17.0 kcal/mole is one of the most common energy barriers in physiological processes and individual enzyme systems.



○, △ - Patterson Department of Agriculture Belfast (1975), pers. comm.

Fig. 2 — Relative rate spoilage curve.

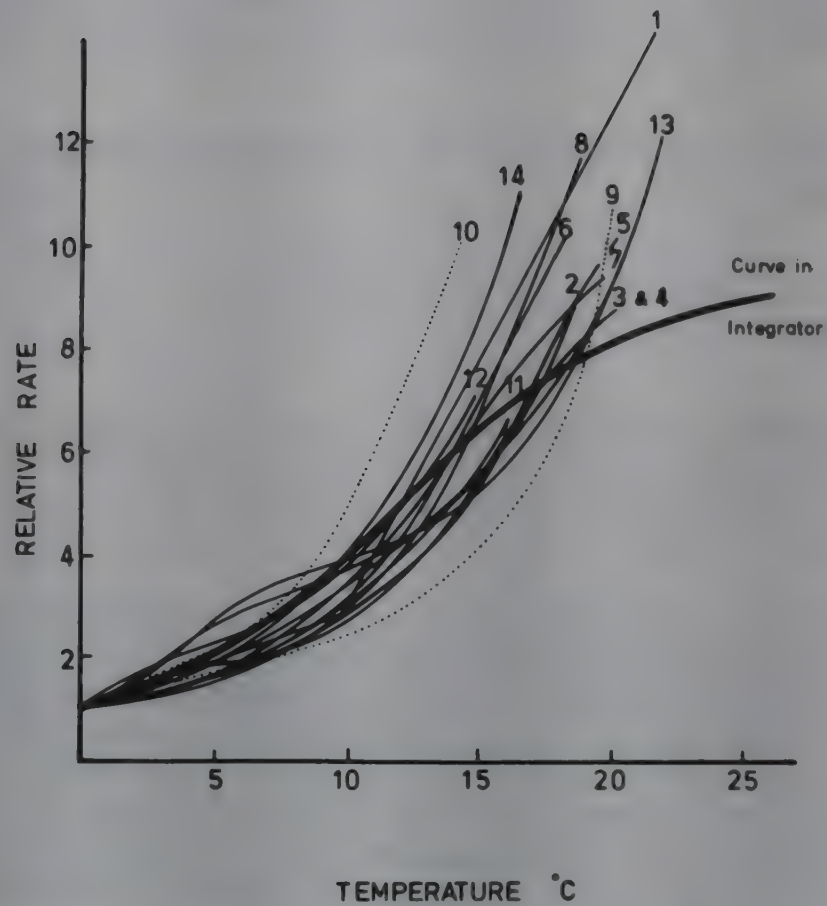


Fig. 3 — Relative rate spoilage curves for the poultry systems listed in Table 1. Dotted lines indicate the growth of Group II *Pseudomonads* on the substrates arginine and asparagine.

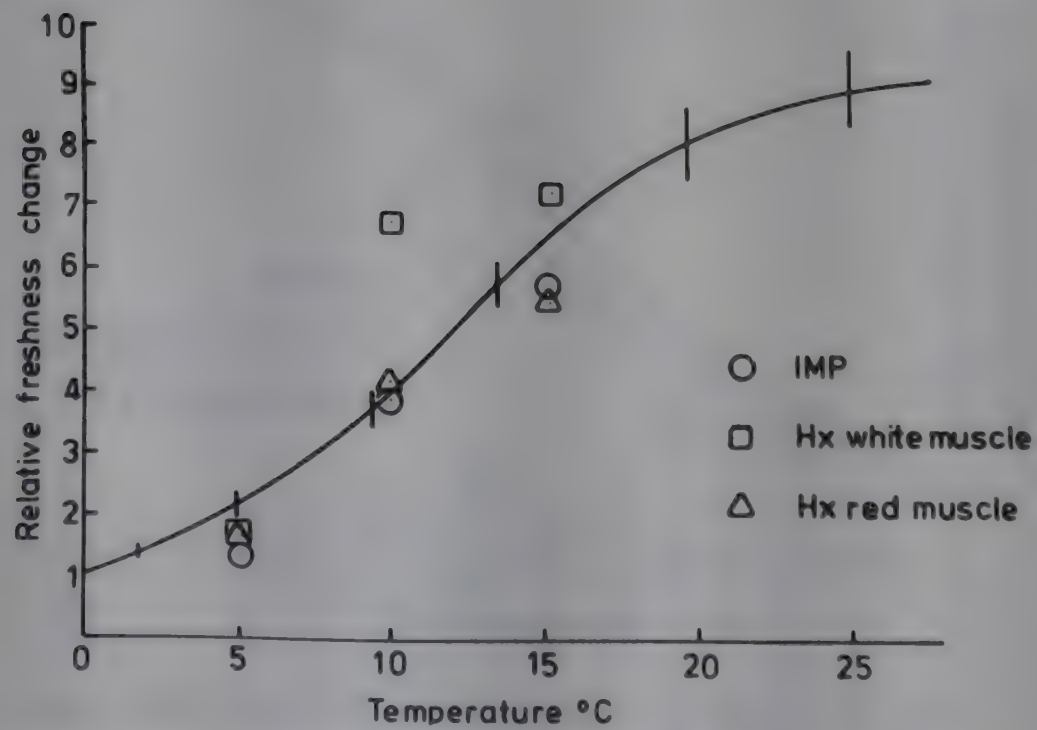


Fig. 4 — Relative rate of freshness change plotted together with Olley & Ratkowsky spoilage curve.

RELATIVE RATES OF CHANGE IN THE FRESHNESS INDEX

The measurement of spoilage is a negative approach and more recently much effort has been expended on the measurement of decrease in freshness, see for example, Ehira (1976). This approach is to measure the *post mortem* breakdown of the energy-rich nucleotides, from their levels in live muscle, to such compounds as inosine monophosphate (IMP) and hypoxanthine (Hx). Fig. 4 shows that these compounds appear to fit quite well on the O & R calculated curve from the very limited Canadian data on mackerel (Fraser *et al.*, 1968), which the authors have found in the literature.

CAN RATES OF SPOILAGE RELATIVE TO THAT AT 0°C ALWAYS BE PREDICTED?

It is assumed that loss of freshness or noticeable spoilage follows a definite sequence of events. Thus, bacteria go from a 'lag phase' into a 'logarithmic phase' of growth (Ireland, 1977) and the predominant species of bacteria present change with time in a predictable manner. Adenosine triphosphate breaks down to IMP and Hx through defined enzymic and microbial pathways. These reactions will occur at expected rates if products are carefully looked after. Extraneous reactions will occur if fish are trodden on with heavy boots, dropped while frozen, squeezed against the hold of the ship, subjected to pressure at the bottom of large holds, or handled by personnel with septic wounds. The relative rate curves are based on the best possible conditions with normal relative humidity and oxygen tensions.

HOW TO BUILD UP A RELATIVE RATE CURVE

At the IPFC Working Party in Sri Lanka, Olley (FAO, 1977) gave three examples of spoilage levels which could be used in building up relative rate curves.

Oil sardine		percentage of burst bellies
Shark		ammonia development
Shrimp		total volatile base (TVB)

It should be noted that the actual percentage or amounts were not specified.

If reactions or changes follow a definite pattern then the relative rates of change should apply at any point. This is illustrated in Fig. 5.

Chemical changes may be measured but these require laboratories. Visual assessments in conjunction with score sheets as developed for whitefish (Baines and Shewan, 1965) and snapper (Boyd and Wilson, 1976) are more appropriate to the dockside or factory. The Torry freshness meter (Cheyne, 1975; Merican *et al.*, 1978) as it becomes more readily available will also be a useful tool.

HOW TO USE THE RELATIVE RATE CURVE

If the whole temperature history of a product is known, its remaining shelf-life before spoilage can be determined, provided that the usual storage life of the product at 0°C is already known. An example was given by Olley (1977) based on the observations of Nixon (1971) aboard a New Zealand fishing boat. The exercise is reproduced here for completeness. Nixon followed the temperature history of the fish stored in a refrigerated hold until landing. The hours at each temperature were multiplied by the appropriate relative spoilage rate to give equivalent hours on ice. The results are shown in Table 2; the fish had the equivalent of 75.4 hours on ice.

By the inadequate chilling of this fish, an equivalent of two days on ice was lost before the fish got to the fish market and the distance inland at which it could be sold was decreased by two days. Similar calculations were carried out to follow the time-temperature tolerance of fish in the U.K. through unloading at the port, subsequent rail transport and display in the retail shops (Burgess and Cutting, 1959).

A PLEA FOR FURTHER WORK

The authors trust that the explanations given here are sufficiently explicit for work to be done on tropical species. Because the initial bacterial flora on tropical species are adapted to high temperatures, Olley (1977) has warned that there may be differences in spoilage patterns compared to those on fish caught in cooler waters. This does not mean that the relative rate curves will be different, but it adds a note of caution.

Future work on the spoilage of tropical species should be done at a minimum of two temperatures for the reasons given in the introduction to this paper and also to build up the relative rate curves with more confidence.

With limited research facilities, it may be necessary for workers to concentrate on the temperature range at which their species are held for the longest period. Kamari *et al.* (1977) have described some Malaysian species as unfit for fresh consumption within sixteen hours and mention the limited use of ice at ambient temperatures of 24-35°C. They would probably be interested in the relative rates of spoilage between 10-15°C. Relative rates in this range, where the curve rises sharply, are in most need of definition for fish which spoil rapidly, particularly if they are not iced, while temperatures in the 0-5°C region are most important for expensive species which are to be stored in ice for longer periods and transported over great distances.

Table 2

Marketable life of fish used up in a trawler hold

Temperature (°C)	Time at temperature stated (hours)	Relative spoilage rate (from O & R curve)	Equivalent hours in ice (rate x time)
15.0	2	6.5	13.0
14.7	1	6.4	6.4
13.5	1	5.8	5.8
10.8	1	4.3	4.3
9.4	1	3.6	3.6
8.6	4	3.3	13.2
7.5	2	2.9	5.8
5.0	2	2.65	5.3
3.5	10	1.8	18.0
	24		75.4

Shewan (1977) has listed the shelf-life of various species of fish on ice; these range from 2 to 28 days. The tropical species, if properly iced, often have the longest shelf-life.

The outer limits of the relative rate curves for model poultry systems are likely to be typical of the scatter of data to be found for fish because the poultry data spanned the expected limits of activation energies. The maximum scatter of poultry data represented by an upper and lower boundary line up to 16°C is shown in Fig. 6 together with the original data from which the O & R curve was derived.

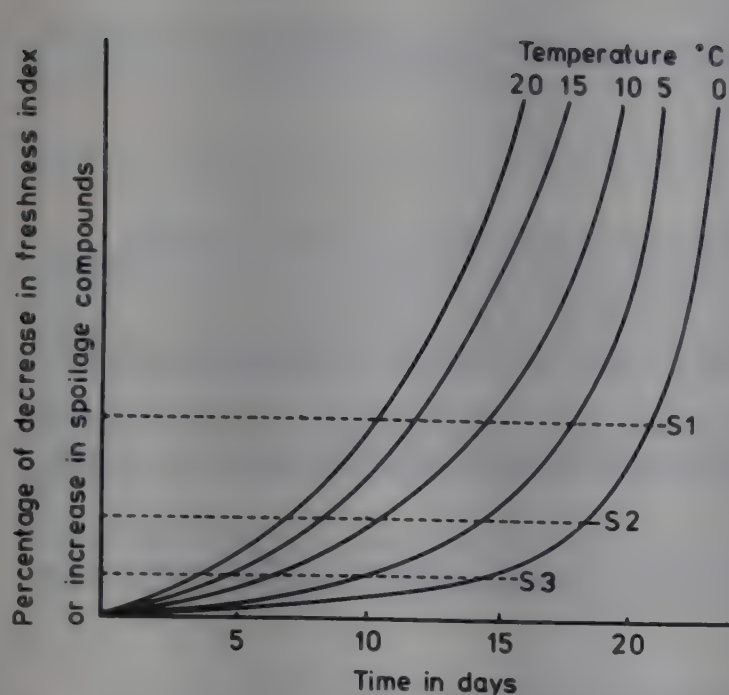


Fig. 5 — The construction of a relative rate curve. S3, S2 and S1 specified spoilage levels at early, medium and advanced stages of spoilage respectively.

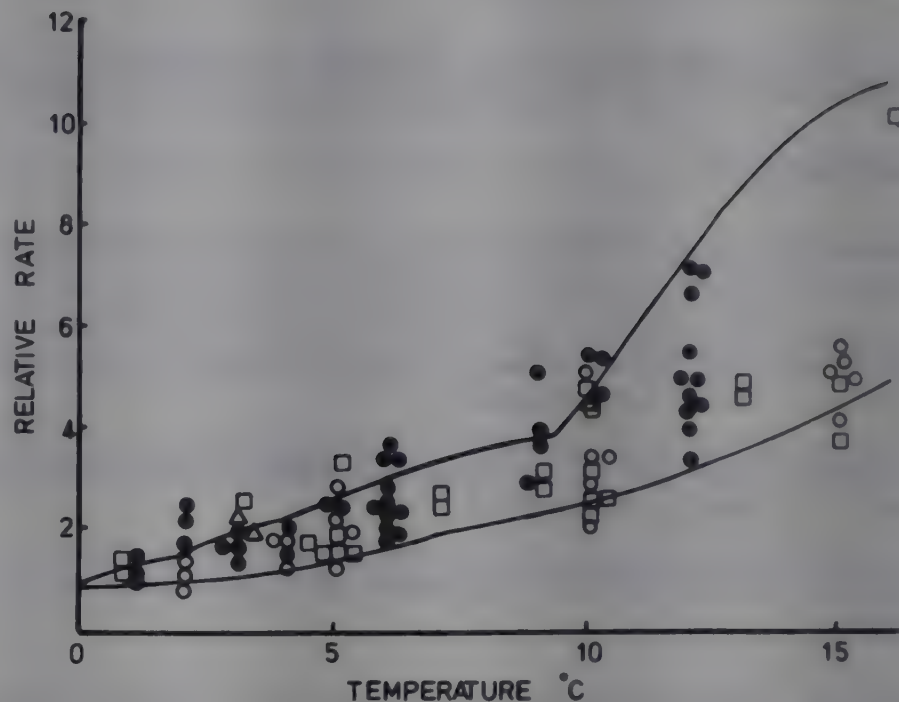


Fig. 6 — Relative rate data used to derive O & R curve.

The poultry curves were obtained using a temperature gradient incubator and are derived from many data points for each system. The original data for the O & R curve were obtained from isolated information on meat, fish and poultry. Most of the original O & R data fall within the limits of the model poultry systems and this has been used for the general prediction of fish spoilage in Table 3.

Table 3

Limits within which shelf-life of fish can at present be predicted

Temperature (°C)	Fish with maximum shelf-life of 2 days	Fish with maximum shelf-life of 28 days
	Shelf-life (hours)	Shelf-life (days)
15	4.5 — 10.5	2.5 — 6
5	17 — 30	10 — 18
0	48	28

Data for temperatures above 15°C have not been considered, as Fig. 6 shows a large scatter of data even at 10°C. This is probably because, at the higher temperatures, measurements should be made hourly rather than daily if better prediction is required. It should also be remembered that foodstuffs should always be kept below 8°C to avoid the proliferation of pathogenic bacteria, that fish is a poor conductor of heat and any large mass will cool down slowly (Nicol, 1959).

For completeness and a thorough understanding of the phenomena to be observed, the sea-water temperature when the fish were caught should always be recorded.

REFERENCES

- Baines, C.R. and J.M. Shewan, Sensory methods for evaluating the quality of white fish. *Lab.Prac.*, 14:160-3
1965
- Boyd, N.S. and N.D.C. Wilson, A sensory method for evaluating the quality of snapper (*Chrysophrys auratus*).
1976 *N.Z.J. Sci.*, 19:209-12
- Burgess, G.H.O. and C.L. Cutting, The need for lower temperatures in distribution of fish. *Proc. Int. Congr.*
1960 *Refrig.*, 10(3):160-4
- Cheyne, A., How the G.R. Torrymeter aids quality control in the fishing industry. *Fish. News Int.*, 14(12):71-6
1975
- Ehira, S., A biochemical study on the freshness of fish. *Bull. Tokai Reg. Fish. Res. Lab.*, (88):1-132
1976
- FAO, Report of the second session of the IPFC working party on fish technology and marketing. IPFC, 17
1977 Session, Colombo, Sri Lanka.
- Fraser, D.I., D.P. Pitts and W.J. Dyer, Nucleotide degradation and organoleptic quality in fresh and thawed
1968 mackerel muscle held at and above ice temperatures. *J. Fish. Res. Board Can.*, 25(2):239-53
- Ireland, J., An introduction to microbiology. In Proceedings of 1977 School for Seafood Processors, Richmond,
1977 N.S.W. Hawkesbury Agricultural College, edited by A.F. D'Mello, p. 2.1-2.20
- Kamari, A., A.Z. Idrus and Z. Merican, The handling and transportation of fish in Malaysia. In Proceedings of the
1977 conference on handling, processing and marketing of tropical fish. London, Tropical Products Institute, p. 115-9
- Laidler, K.J., Unconventional applications of the Arrhenius Law, *J.Chem.Educ.*, 49:343-4
1972
- Merican, Z., A. Kamari and P.F. Lam, Use of Torrymeter to assess quality of Malaysian fish. Paper presented to
1978 the symposium on fish utilization, technology and marketing in the IPFC region. Manila, Philippines,
1978
- Morales, M.F., A note on limiting reactions and temperature coefficients. *J. Cell. Comp. Physiol.*, 30:303-13
1947
- Nicol, D.L., Some aspects of the rail transport of wet fish. *Mod. Refrig.*, 62:451-4
1959
- Nixon, P.A., Temperature integration as a means of assessing storage conditions. In Report on quality in Fish
1971 Products Seminar No. 3. Wellington, Fishing Industry Board, p. 34-44

- Olley, J., Temperature indicators, temperature integrators, temperature function integrators and the food spoilage chain. *Annex 1976-1 Bull. IIR*, Commission C2, D1, D2, D3, E1, Melbourne, Australia
1976
- _____, Temperature and seafood spoilage. *In Proceedings of 1977 School for Seafood Processors*,
1977 Richmond, N.S.W. Hawkesbury Agricultural College, edited by A.F. D'Mello. p. 6.1-6.16
- Olley, J. and D.A. Ratkowsky, Temperature function integration and its importance in the storage and distribution of flesh foods above the freezing point. *Food Technol. Aust.*, 25(2):66-73
1973
- _____, The role of temperature function integration in monitoring of fish spoilage. *Food Technol. N.Z.*, 8(2):13-7
1973
- Shewan, J.M., The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action. *In Proceedings of the conference on handling, processing and marketing of tropical fish*. London, Tropical Products Institute, p. 51-66
1977
- Spencer, R. and C.R. Baines, The effect of temperature on the spoilage of wet white fish. 1. Storage at constant temperatures between -1°C and 25°C . *Food Technol. U.S.A.*, 18(5):175-9
1964
- White, A., P. Handler and E.L. Smith, Principles of biochemistry. Tokyo, McGraw-Hill Kogakusha Ltd., 235 p.
1973 5th ed.

A PRELIMINARY STUDY ON THE QUALITY OF FRESH FISH TRANSPORTED BY CARRIER BOATS ALONG THE BOMBAY COAST

by

A.P. Valsan and P. Vasudeva Prabhu
Bombay Research Centre
Central Institute of Fisheries Technology
Bombay, India

Abstract

Specifically designed carrier boats play a major role in transporting the huge fish requirements of Bombay city from far off fishing centres scattered along the west coast of India. This paper critically reviews the various fish handling, icing, stacking and transporting techniques adopted by these carrier boats and studies their effect on the quality of the fish by the time it reaches the consumer. Based on the data collected, some suggestions are put forward for the improvement of this important large-scale fresh fish transport system.

INTRODUCTION

In a tropical country like India there are problems in the handling and transportation of fish. This is because the marine fish are landed at innumerable fishing hamlets scattered along an extensive coastline of about 5,000 km (Venkataraman *et al.*, 1976). Also the major fish-consuming centres are far away from the landing centres. The problem of transporting this highly perishable commodity in a prime condition from the producing centre to the consuming centre is enormous. Various means of transport are currently used in India, i.e., road, rail, sea or other waterways. This paper places on record some preliminary investigations on a system of bulk transport for fresh fish using specially designed carrier boats.

The metropolitan city of Bombay has a population of about 6 million and is one of the major fish-consuming centres of India. The *per caput* fish consumption of the city is estimated to be 16 kg each year, whereas the fish consumption for the whole of India is only 1 kg. Local fish catches are hardly sufficient for the city's needs. Consequently fish is brought into the city often from neighbouring states such as Gujarat in the north coast and Karnataka in the south by sea, road or rail. It is estimated that about 200 tonnes of fish flow into the city everyday. Large quantities of fresh fish are transported by the fish carrier boats.

The carrier boats are designed as bulk carriers of fresh fish. They travel to Bombay from distant places such as Veraval on the Gujarat coast or Karwar on the Karnataka coast. The distance between Veraval and Bombay by sea is approximately 350 km and the journey takes between 24 and 30 h depending on the weather. A large quantity of mackerel comes from Karwar taking about 30 h to reach the city. Many of these boats are also engaged in transporting highly priced fish such as silver pomfret, black pomfret, seer, hilsa, eel *Chirocentrus* sp., rawas, perches, shrimp, etc.

These carrier boats are of varying capacities up to 40 tonnes. In addition to diesel-driven motors, most of the boats have auxiliary sail power, for use when the weather conditions are favourable. They generally have wooden hulls and most are provided with insulated holds for the storage of iced fish. The holds are divided into compartments with separate hatches. Since the boats are bulk carriers they are generally used only at the peak fishing season. When the catches are light the fish are stored in ice at a central location and, when an adequate quantity accumulates, the cargo is dispatched by the carrier boat. Hence it is quite possible that the carrier boat transports catches from different days and, possibly, of different quality (Venkataraman, *et al.*, 1966).

LOADING OF CARRIER BOATS

The fresh fish are brought to a port where the carrier boats can berth. The fish are not packed in separate boxes or containers but are immediately loaded in the cleaned holds of the carrier boats. It is noteworthy that the fish are seldom gutted; gutted fish fetch a lower price in Bombay markets. A liberal supply of crushed ice is generally used to store the fish for transport; it is reckoned that the ice: fish ratio is at least 1:1 and possibly 2:1. A generous amount of crushed ice is laid at the bottom of the hold. Fish, sorted according to variety, are then press-packed in separate piles with a liberal quantity of crushed ice between each layer. Care is taken to exclude all air pockets. Similarly a thick layer of ice is spread on top of the fish stack. The fish stack is about 1.2 to 1.5 m in height. When the hold is full the hatch is closed. In each of the holds, the ice melt-water can drain into the bilges which are occasionally pumped out. Hence, there is no accumulation of water in the hold. In the case of highly priced fish, such as pomfrets, particular care is taken in the packing process. These fish are packed in a vertical position in neat rows supported by crushed ice. This minimizes damage to these delicate fish and reduces the consequent deterioration. Extra care is also taken of the shrimp which are further processed for export. Usually the shrimp are beheaded, packed in separate plywood boxes with crushed ice and stacked one above the other inside the hold.

After loading, the carrier boats set out for Bombay where they are berthed along the fishing wharf. Irrespective of the time of arrival unloading takes place late at night after, say, 23.00 h. This ensures that, firstly the unloading is completed at daybreak so that the fish can be taken immediately to the wholesale fish market by lorries for early morning auction and further retail distribution. Secondly, the temperature conditions are lower at night and the wharf is not too congested at this time. The labour force (protected with gumboots) enters the holds and starts to break the ice-fish stacks with spades, pick axes, crowbars, etc. The ice is removed from the hold and taken in baskets to the pier. Then the fish are similarly transferred. During unloading a considerable quantity of fish are bruised, cut or otherwise damaged. On the pier the fish are once again sorted into species and are then loaded in open trucks with ice. When each lorry is full it is driven to the wholesale market where the fish are again sorted and auctioned; this is completed in the early hours of the morning.

MATERIAL AND METHOD

Visits were made to carrier boats when the fish were being unloaded. Representative samples of different species were taken from a number of boats. The fish were brought to the laboratory in ice and were subjected to organoleptic biochemical and bacteriological examination. Since the fish stacks in the hold were 1.2-1.5 m high it was thought that the fish at the bottom might be adversely affected by the heavy load above. Therefore, the fish pile was examined at different levels. Each 30 cm was treated as one layer. The layers were counted from the top downward. One to two percent of the total fish from each layer was taken separately for organoleptic assessment. From these, representative samples were taken for biochemical and bacteriological examination. For the purposes of organoleptic assessment, the fish were classified into the following five arbitrary grades ranging from excellent to poor:

<i>Grade I</i>	—	Excellent:	Bright appearance, clear bright eyes, bright red gills, firm texture, characteristic fresh fish odour.
<i>Grade II</i>	—	Good:	Slightly dull appearance, bright eyes, red gills, firm texture, fresh fish odour.
<i>Grade III</i>	—	Fair:	Slightly dull appearance, eyes not very bright, red gills, firm texture, fishy odour.
<i>Grade IV</i>	—	Satisfactory:	Dull appearance, dull eyes, brownish-red gills, soft texture, strong fishy odour.
<i>Grade V</i>	—	Poor:	Dull appearance, dull sunken eyes, brown gills, soft pulpy texture, unpleasant off odour.

In the case of silver pomfrets, the colour of the gill mucus was an added factor for grading. Grades I and II: white mucus; Grade III: dull white mucus; Grade IV: red mucus; Grade V: brownish-red mucus (Kamasastri *et al.*, 1967).

Moisture was determined by the AOAC method 1960. Total volatile nitrogen (TVN) and trimethyl amino nitrogen (TMAN) were estimated by the Conway microdiffusion technique (1947). Total bacterial count was estimated by the pour plate method using tryptone glucose agar, *E. coli* using Tergitol-7 agar, coagulase-positive *Staphylococci* using Chapman Stone medium and faecal *Streptococci* using KF gear.

RESULTS AND DISCUSSION

Table 1 presents the chemical and bacteriological quality of some of the common varieties of fish at the stage of unloading at Bombay. The data are the maxima and minima of above 20 random samples from each variety of fish drawn from five carrier boats. Although a wide range of results can be seen, spoilage indices such as TVN and TMAN are mostly within the satisfactory range except in a few instances. This was confirmed by a moderate total plate count. The incidence of *E. coli* was rare but *Staphylococci* and *Streptococci* were recorded in moderate numbers in most of the samples.

Table 1

Biochemical and bacteriological quality of fish from the carrier boats

Species	Range of values	H ₂ O (%)	TVN (mg %)	TMAN (mg %)	TPC (per g)	Streptococci (count/g)	Staphylococci (count/g)	E. coli (count/g)
Silver pomfret	Max.	79.66	12.6	2.4	3.10×10^5	154	328	Nil
	Min.	74.85	15.7	1.4	4×10^4	82	Nil	Nil
Black pomfret	Max.	76.38	18.5	2.8	1.05×10^5	425	29	Nil
	Min.	75.82	13.6	0.9	1.8×10^4	40	20	Nil
Hilsa	Max.	73.16	15	2.8	1.67×10^5	119	50	Nil
	Min.	71.86	14.7	2.8	1.6×10^4	54	Nil	Nil
Catfish	Max.	79.38	18.5	3.5	4.28×10^4	145	126	Nil
	Min.	76.86	14.7	3.2	1×10^4	27	18	Nil
Caranx sp.	Max.	77.00	16.4	2.1	5×10^4	210	206	Nil
	Min.	74.85	14.1	1.4	3.95×10^4	19	Nil	Nil
Fellona	Max.	77.23	16.1	3.5	1.48×10^5	171	50	Nil
	Min.	73.86	13.4	0.7	6×10^4	56	—	Nil
Chirocentrus sp.	Max.	81.34	22	4.2	5.95×10^5	185	345	26
	Min.	76.30	10.5	0.1	6.4×10^3	18	72	16
Seer	Max.	78.81	21.2	4.5	8.3×10^4	200	125	Nil
	Min.	78.57	18.5	2.1	2.1×10^4	115	17	Nil

Mackerel	Max.	73.55	21.7	3.6	2.81×10^4	89	—	—
	Min.	72.40	20.3	3.5	2×10^4	75	—	—
Eel	Max.	77.41	25.2	5.6	4.4×10^5	86	38	—
	Min.	76.85	21.3	4.2	3.9×10^4	19	—	—
Prawn	Max.	82.64	30.5	2.8	8.0×10^5	420	200	—
	Min.	80.21	21.4	1.4	6.7×10^4	122	89	22

Table 2 indicates the effect of fish stack height on the quality of fish. The grading was carried out organoleptically according to the arbitrary standards referred to earlier; the data relate to samples from one carrier boat and are expressed as a percentage, in each grade, of the total number of fish in each layer. The percentage of fish damaged by rough handling while unloading is also given in the table. As the fish were stored in ice for more than 30 h, none could be classed as Grade I. These data clearly indicate that quality declines toward the bottom of the stack.

Although the data are not very extensive, they indicate the quality of fresh fish by carrier boats in bulk to Bombay. Overall, 51 percent were of good quality, 35 percent of fair quality, 13 percent of satisfactory quality, with a negligible percentage of poor, substandard quality. During the unloading operation 1 percent of the total number of fish were badly bruised, cut or otherwise damaged; this may be attributed to the mass bulk piling of fish and ice and the use of crude pick axes, spades and crowbars, etc., to unstack the fish when unloading.

Table 2

Grading of fish, by layer, from the fish stack

Layer	Grading of fish					Damage due to rough handling (%)
	Grade I (%)	Grade II (%)	Grade III (%)	Grade IV (%)	Grade V (%)	
Top layer	Nil	74	21	5	0	2
Second layer	Nil	58	31	11	0	1
Third layer	Nil	51	38	11	0	1
Bottom layer	Nil	23	51	24	2	1
Percent of total load	Nil	51	35	13	1	1

CONCLUSIONS

The carrier boat system is an effective method of transporting fish in bulk but it is slower than road and rail transport. Since the transport is by sea, the temperature conditions are cooler compared to land transport. Furthermore, the fish will be subjected to less banging and agitation during a sea journey as compared to high speed rail or road transport. The system could be improved further if a shelving system was installed in the hold at a

height of about 1 to 2 feet. Alternatively fish could be packed in separate boxes which can be stacked in the hold. This will substantially hasten the process of loading and unloading and minimize the damage to the fish. In the present system of stack piling of the fish, the height of the pile should be restricted to at least 3 feet. Similarly, gutting the fish and thoroughly cleaning them prior to loading may further improve the quality of the fish transported by these bulk carriers.

ACKNOWLEDGEMENTS

The authors are indebted to Shri G.K. Kuriyan, Director of Central Institute of Fisheries Technology for the kind guidance and permission to publish this paper. They express their gratitude to Shri M.R. Nair Project Coordinator and Shri R. Venkataraman, Senior Bacteriologist for the keen interest and encouragement they extended throughout this investigation.

REFERENCES

- AOAC, Official method of analysis. Washington, D.C., Association of Official Agricultural Chemists, 237 p.
1960 (9th ed.)
- Conway, E.J., Microdiffusion analysis and volumetric error. London, Crosby Lockwood and Sons
1947
- Kamasastri, P.V., V. Ghadi Sadanand and D. Ramamanda Rao, *Fish. Technol., Ernakulam*, 4(2): 72
1967
- Venkataraman, R., P.V. Prabhu and D.J. Mankad, IPFC, 12th Session 67/8 (IPFC/C 66/Tech 38)
1966
- Venkataraman, R. *et al.*, *Fish. Technol., Ernakulam*, 13(1):43
1976

THE FEEDING OF 'WILD' EELS: A PRELIMINARY INVESTIGATION

by

J. Sumner and G. Hopkirk

Department of Veterinary Science, Lincoln College
Canterbury, New Zealand*Abstract*

'Wild', short-finned eels (*Anguilla australis*) taken from Lake Ellesmere, Canterbury, New Zealand, were held in ponds and fed a proprietary brand of eel. After an initial period of rejection the eels accepted the feed. Over the four-month feeding period the lipid content increased to 15 percent compared with a maximum of 12 percent for eels taken from Lake Ellesmere and 8 percent for eels taken from river systems.

INTRODUCTION

The New Zealand eel industry is based predominantly on the export of the short-finned eel (*Anguilla australis*) to a number of European markets (see Sumner and Hopkirk, 1976). The rise in the export of New Zealand eels has been dramatic; in 1975 some 2 346 tonnes with an export value of N.Z\$ 2 720 000^{1/}) placed eels in first place, in value, among finfish exported.

Although the farming of eels has been attempted by a number of companies, no venture has proved viable (Jellyman and Coates, 1977).

Unfortunately, compared with the European eel (*Anguilla anguilla*) and the Japanese eel (*Anguilla japonica*) the New Zealand eel has a much lower lipid content, which reduces the value considerably. The lipid content also varies seasonally (Hopkirk *et al.*, 1975), along the length of the eel (Wills and Hopkirk, 1976) and according to the mass of the eel (Sumner and Hopkirk, 1976). The lipid content of farmed New Zealand eels, however, is comparable with that of the European and Japanese eels (Hopkirk *et al.*, 1976) and the possibility of 'fattening' eels to marketable size in holding ponds was investigated.

This paper reports on the results of the fattening experiments.

EXPERIMENTAL

Holding Ponds

Two holding ponds of total area 0.1 ha were fed by a pumped inflow of water (2 000 l/min) to give a depth of 30 cm. The temperature of the inflow water was 14°C while the pond water temperature varied according to ambient, exceeding 20°C during the warmest weather.

Stock

Short-finned eels which had just emerged from hibernation in Lake Ellesmere were netted and brought by aerated tanker to the holding ponds. A total of 300 kg of eels was used.

^{1/} N.Z. \$1.00 = US\$1.02 (April 1978)

Feed

The eels were fed daily from a submerged feeding platform. The feed (5 percent of body weight) was made by mixing sufficient water with a proprietary brand of eel feed (Northern Rolling Mills, Ltd.) to give a paste, adding 10 percent fish oil (Sealord Products, Ltd.) and mixing.

Sampling

At monthly intervals six eels were removed by netting.

Lipid Content

Extraction of lipid and determination of lipid content were carried out as described previously (Sumner and Hopkirk, 1976).

RESULTS AND DISCUSSION

At the inception of the study doubt was expressed whether grown 'wild' eels would feed if held in ponds. Initially, during the first 14 days, the feed was rejected although eels were observed inspecting the food. Later, all the food provided was consumed, the eels swimming to the feeding platform each time the food was brought.

The lipid content of wild eels varied from 5 to 12 percent (Table 1); while the lipid content of eels taken from river systems varied little throughout the summer periods, eels taken from Lake Ellesmere became fatter as the summer progressed. The lipid content of eels held in ponds also increased (Table 1), particularly during the warmer months of January and February.

Table 1

Lipid content of New Zealand eels (*Anguilla australis*) from the natural environment and after feeding in captivity
(Data expressed as lipid percent of net weight)

Month	Source of Material		
	Lake Ellesmere	River Systems ^{a/}	Feed eels
October	7.9	7.5	—
November	5.3	7.2	9.4
December	11.5	6.6	9.0
January	10.2	8.0	15.9
Februray	12.0	7.3	14.4

^aEels were taken from the Opihi River for the October, November and December samples; from the Puni River during January, and the Tairei River during February.

The present study is regarded as no more than a preliminary investigation which indicates that eels can be fattened in holding ponds. A series of experiments is currently in progress to feed a variety of diets to grown wild eels held in a system of concrete tanks. The possibility of fattening eels is becoming increasingly important in the light of diminishing catches, the necessity arising of achieving a greater return for those eels netted.

REFERENCES

- Hopkirk, G., R.B.H. Wills and P.R. Townsend, Seasonal variation in lipid content of eels (*Anguilla australis*).
1975 *Aust. J. Mar. Freshwat. Res.*, 26:271-3
- Hopkirk, G. *et al.*, The New Zealand eel industry. 1. Raw material quality. *Food Technol. N.Z.*, 11:25-9
1976
- Jellyman, D.J. and G.D. Coates, The farming of freshwater eels in New Zealand. IPFC 17th Session, Symposium
1977 on the Development and Utilization of Inland Fishery Resources, Colombo, Sri Lanka, 1976
- Sumner, J.L. and G. Hopkirk, The New Zealand eel industry. 2. Production, processing and storage. *Food Tech-
1976 nol. N.Z.*, 11:13-7
- _____, Lipid composition of New Zealand eels. *J. Sci. Food Agric.*, 27:033-8
1976
- Wills, R.B.H. and G. Hopkirk, Distribution and fatty acid composition of lipids of eels (*Anguilla australis*).
1976 *Comp. Biochem. Physiol.*, 53B:525-7

PROBLEMS OF *SALMONELLA* IN FROGLEGS

by

Posma R. Tambunan and Endang Sri Heruwati
Research Institute of Fishery Technology
Jakarta, Indonesia

Abstract

In the last few years frozen froglegs have become one of the main Indonesian fishery exports. However, the occurrence of *Salmonella* is a serious problem, resulting in detention and rejection of a considerable volume of shipments by the importing countries.

In this context, the Research Institute of Fishery Technology, Jakarta, has conducted a series of experiments to investigate the problem. The results show that froglegs kept at ambient temperature deteriorate rapidly and become unacceptable after seven hours, while icing the legs prolongs the shelf-life to four days.

To collect more information, studies have been carried out on the occurrence of *Salmonella* in live frogs, both in quarantine conditions as well as in fresh froglegs received at processing plants. Cases of the occurrence of *Salmonella* on the skin vary between 4 and 16 percent, 10 to 26 percent in the intestine and 3 to 14 percent in the legs.

It was shown that dipping the legs in 200 ppm of chlorine solution for ten minutes gives good results in eliminating *Salmonella* from whole and skinned legs.

INTRODUCTION

The export of froglegs has become an important Indonesian industry. In 1974, however, exports to the U.S.A. suffered a serious set-back because of rejection of a considerable volume by the U.S. Food and Drug Administration due to the presence of *Salmonella*. The Research Institute of Fishery Technology, Jakarta, has conducted a series of experiments to investigate this problem. This report contains the findings and recommendations.

Frozen froglegs are exported from Indonesia to the U.S.A., France, Europe and a few other countries. In Indonesia frogs are found in almost all swampy waters, paddy-fields, irrigation waters, etc., and are mainly collected from Java, South Sulawesi and Sumatra. Frogs are usually caught by hand at night with the aid of bright lanterns. Only the legs are delivered to the plants, sometimes packed with ice, sometimes without.

EXPERIMENTS

In 1973, the Research Institute of Fishery Technology started observations on the deterioration of froglegs at room and chill temperatures in an attempt to study the deterioration pattern. Froglegs cut from live frogs and held at room temperature (between 26.8 and 32.0°C) showed a very rapid decrease in quality. Organoleptic evaluation was carried out hourly and the rejection level was reached in 7 h. Froglegs kept in crushed ice or chilled water were rejected after four days. An increase in water content took place in the legs during chill storage, both in ice and in chilled water. The water content of the freshly dressed froglegs was 80.6 percent; after

84 h in crushed ice the water content was 86.0 percent and 88.2 percent in the legs kept in chilled water.

An experiment was also carried out to study the role of ecological factors on the occurrence of *Salmonella* in the froglegs. The results showed that some samples were contaminated with *Salmonella*. This may result from the environment; for example, duck faeces are invariably contaminated with *Salmonella*.

A more detailed experiment was conducted to collect information on *Salmonella* contamination in live frogs, to test the effectiveness of quarantine methods and also to establish the degree of *Salmonella* contamination in the commercial froglegs. The presence of *Salmonella* was determined by microbiological and biochemical means. Samples of live frogs were purchased from a market in Jakarta; they had been caught in the Krawang area 200 km from Jakarta. Samples of commercial froglegs were taken from one of the commercial freezing plants in Jakarta.

A plastic basket was used for quarantine treatment. Live frogs were held in the basket under running water so that all the excreta of the frogs, including bacteria, were removed. The quarantine treatment was carried out for 24 hours.

The results of the experiment showed that from 100 live frogs, 4-16 percent were contaminated with *Salmonella* on the skin, 10-26 percent in the intestine and 3-14 percent on the legs. The experiment also showed that there is a relationship between the *Salmonella* contamination of the intestines and skin and between that of the intestines and legs. No relationship was apparent between the *Salmonella* contamination of the legs and skin.

It is assumed that if the intestine is contaminated by *Salmonella* there is a possibility that the legs will also be contaminated. *Salmonella* are concentrated mainly in the intestine followed by the skin; only a small number was found in the legs.

The quarantine method used in the experiment appeared to be ineffective in reducing or eliminating *Salmonella*. The results showed that 17-21 percent of the quarantined frogs had *Salmonella* on the skin and 18-36 percent in the intestine.

Of the commercial froglegs, 17 percent were contaminated with *Salmonella*.

Decontamination studies of commercially-caught frogs and froglegs were carried out using chlorine solutions of various strengths and with various dipping times. Eight treatments were applied to live frogs and dressed and skinned froglegs. Samples were also dipped after inoculation with *Salmonella*.

All chlorine treatments reduced contamination but, considering both economic and technical factors, dipping in a 200 ppm solution of free chlorine for ten minutes was the optimum.

CONCLUSIONS AND RECOMMENDATIONS

As frogs come from habitats such as rice field, ponds, irrigation systems, etc., which are contaminated with human and animal excreta, they will probably be contaminated with *Salmonella* in the intestine and on the skin. Legs cut from such frogs can easily become contaminated and it was shown that commercially-butchered frogs were affected. The quarantine method investigated was found to be unsatisfactory.

Although it was shown that all chlorine treatments effectively decontaminated froglegs, this may be difficult to apply in practice. In these studies, treatment was started with live frogs whereas in practice butchering

usually takes place in the field where facilities are unavailable. Further work is necessary to determine the effectiveness of chlorine on potentially contaminated legs which have been held under unfavourable conditions. Every efforts should also be made to treat frogs as soon as possible after capture and to keep the legs under good conditions throughout the distribution chain. It will be necessary to carry out extensive work in the industry in order to ensure safe production

RELATED LITERATURE

- Heruwati, E.S. and P. Rosmawaty, Efektifitas perlakuan larutan chlor untuk mendekontaminasi *Salmonella* pada paha kodok. *J. Penelitian Teknologi Hasil Perikanan*, (1) 1976
- Ilyas, S. and Saifurridjal, Studi kenunduran mutu. Pengamatan kenunduran mutu paha kodok pada suhu dingin. *Laporan Penelitian Lembaga Teknologi Perikanan, Jakarta*, (1) 1973
- Suparno and E.S. Heruwati, Pengamatan mutu bakteriologis terhadap raw material, cara penanganan dan pengolahan paha kodok. *Laporan Penelitian Lembaga Teknologi Perikanan, Jakarta*, (2) 1974
- Tambunanan, P. and Poerwadi, Pengamatan adanya *Salmonella* pada kodok hidup, percobaan dengan karantina dan kodok yang dipotong secara komersil. *J. Penelitian Teknologi Hasil Perikanan*, (1) 1975

AN INVESTIGATION INTO THE UTILIZATION OF
THE TROPICAL RED SNAPPER (*LUTIANUS BOHAR*)

by
A. Hoffman
and
S. Vidot

Fisheries Department
Ministry of Agriculture
Mahe, Seychelles

Abstract

Red snapper (*Lutianus bohar*) is available in the Seychelles in quantities which could make it commercially important. This fish, known locally as vara-vara, is not a popular food fish.

This paper gives the chemical and carcass composition of vara-vara, indicates the effect of iced and frozen storage on quality and shows how the acceptability of the fish may be improved by smoking and by using the flesh for the production of fish cakes. The production of fish silage for animal feed is also considered.

INTRODUCTION

The Seychelles archipelago consists of four scattered island groups in the western part of the Indian Ocean between 4°S to 10°S and 46°E to 56°E. While most of the islands are coralline, the one and only group of granitic islands at the northern end of the archipelago supports 99 percent of the total population of 62 000. Victoria, the capital and only deep-water port, is situated in Mahe which is the most important island of the granitic group.

As would be expected for an insular state with a total land area of only 443 km², fishing constitutes an important socioeconomic activity. The present fishing fleet consists of some 400 vessels ranging from 5 m to 15 m in length. The larger ones are decked, crewed by 5-6 men, and carry ice for preservation of the catch, can operate up to 150-mi from port on trips lasting between 5 and 10 days. Although bamboo traps are used extensively in the in-shore areas, the most common fishing gear is the vertical handline, which can yield catches of up to 50 kg/man-hour. Present yearly fish landings in Seychelles are estimated to be around 6 000 tonnes.

It is generally accepted that the potential is far above the present level of exploitation and that the optimum utilization of the fishery resources within the 200-mi economic zone will result in substantial benefits to the Seychelles economy particularly through exports. So far, the small-scale industry has caught a variety of demersal species such as snappers, groupers and breams. A small export trade has developed in recent years based predominantly on *Lutianus sebae*, *Variola louti*, *Epinephelus flavocaeruleus*, *E. chlorostigma* and *E. fasciatus*. Another species, namely, the snapper *Lutianus bohar*, locally known as vara-vara, has been difficult to market both at home and abroad since it is often lean and tough to eat.

In 1976, through the assistance of the Tropical Products Institute (U.K. Ministry of Overseas Development), a laboratory was set up within the Fisheries Division to investigate the post-harvest problems associated with the development of the fishing industry in general and of the fish export trade in particular. As *Lutianus bohar* is estimated to represent about 10 percent of the known demersal fish potential and is greatly underutilized, an investigation into the handling and utilization of this species was warranted.

CHEMICAL ANALYSIS

Oil and moisture contents were assayed on four vara-vara at approximately monthly intervals between April and November. Duplicate samples of muscle (and skin) were removed from the dorsal area just behind the head. Moisture assays were carried out on skinless muscle by heating the samples in an air oven at 105°C overnight.

The oil assays were carried out by the Soxhlet method using petroleum ether, b.p. range 60-80°C, as a solvent. The assays were carried out on samples which were cut in the shape of a cube and which consisted either of muscle only or muscle, skin and scales. The results of the assays are given in Table 1.

Table 1

Moisture and oil content of vara-vara (mean values for 4 fish)

	April	May	July	September	October	November
Moisture, % Range	79 (77 - 80)	78 —	77 (75 - 78)	75 (74 - 77)	77 (76-77)	77 (77 - 78)
Oil, flesh only % Range	1.3 (0.6 - 2.5)	0.4 (0.2 - 0.6)	0.3 (0.1 - 0.4)	1.2 (0.7 - 1.5)	1.0 (0.6 - 1.5)	0.5 (0.2 - 0.7)
Oil, flesh including skin % Range	— —	— —	1.1 (0.2 - 2.5)	2.3 (1.6 - 3.2)	4.3 (3.5)	1.0 (0.4 - 1.6)

There is a wide range of oil content of fish caught in the same months and often on the same occasion. Although the data for the period December to March were not available at the time of writing, from the figures so far obtained, there does not appear to be any regular seasonal variation in the oil content of vara-vara caught off Mahe.

The oil content of the muscle samples which include skin is invariably higher than that of muscle only, by a factor of at least two and often by as much as four, indicating that the subcutaneous muscle layer is richer in oil than the remainder of the muscle.

CARCASS COMPOSITION AND YIELDS

Estimations of carcass composition and filleting yields were carried out on nine fish ranging in weight from 1.4 kg to 5.3 kg and the results are given in Table 2. The filleting yields, skin off, seem to be slightly higher for fish above 3 kg in weight but the number of fish examined was not sufficient for statistical analysis.

Table 2

Carcass analysis and filleting yields of vara-vara-fish

	1	2	3	4	5	6	7	8	9	Mean Value
Weight of whole fish, kg	1.4	1.6	2.4	3.0	3.9	4.0	4.1	4.6	5.3	
Weight of gills, %	—	3.9	3.3	3.5	3.1	—	—	—	2.5	3.3
Weight of gut, %	—	6.9	8.0	4.8	5.9	—	—	—	5.7	6.3
Weight of skin, %	7.3	6.7	8.31	7.0	8.2	7.8	—	7.2	7.2	7.4
Weight of skinless fillet, %	30.9	28.6	27.8	30.5	30.6	31.4	34.0	31.9	30.5	30.7
Weight of head and frame, %	51.6	54.0	52.9	54.9	51.8	51.1	48.8	51.3	53.8	52.2

A skin-on filleting yield of 38 percent was obtained for a further 12 fish (range 35-40 percent). This appears to be rather low and is due to the large head of the vara-vara which accounts for some 20 percent of the weight of the whole fish.

A trial was also carried out in which a meat/bone separator was used. An attempt was made to put not only frames but also split heads of fish (around 3 kg in weight) through a Baader 694 meat/bone separator but the heads were too large for the machine and only frames were processed. The yield of minced flesh recovered was of the order of 16 percent. The production of minced products using this material is described in a later section of this paper.

ICED STORAGE OF VARA-VARA

Three iced storage trials were carried out to investigate the following variables:

- (a) Gutting versus non-gutting
- (b) Fish iced immediately (0 h) and fish iced after lying on deck for 6 hours (6 h)
- (c) Large versus small fish

Twelve fish, six gutted and six whole, ranging in weight from 0.7 kg to 2.1 kg, were stored in ice for 20 days. Sensory examinations were made periodically; two gutted and two un-gutted fish were taken after 6, 14 and 20 days' storage and submitted to a taste panel for organoleptic assessment.

Of sixteen vara-vara caught on 27 May 1977, eight were gutted and iced immediately ('O' h) and the remaining eight were allowed to remain on deck for 6 hours ('6' h) before gutting and icing. The fish were then stored in ice for 20 days and were examined visually and organoleptically at various time intervals.

Eight fish, four small (average weight 0.9 kg, range 0.8 to 0.9 kg) and four large (average weight 3.6 kg, range 2.8 to 4.7 kg) were immediately gutted, washed and iced after catching. The fish were stored in ice for 27 days and periodic examinations and organoleptic assessments were made.

Physical changes during iced storage and taste panel scores are shown in Tables 3 and 4. From the results it may be seen that iced vara-vara remain in excellent condition for some 5 days. In one instance (gutted versus un-gutted) the fish were still very fresh after 6 days' iced storage. The fish were still acceptable to the taste panel after 14 days' storage on ice, although by then the external appearance had suffered some loss of quality: there was a noticeable sweet off-odour from the gills and gut cavity, as well as a change in the seaweedy raw odour of the fish, which either disappeared (neutral odour) or became turnipy. Later on, the texture of the cooked fish had become tough and the flesh had less flavour.

- (a) There was only a slight difference in appearance between the fish which were iced gutted and un-gutted and the slight preference of the taste panel for the gutted only became noticeable after 14 days' iced storage. In earlier work, Hoffman *et al.*, (1974) found gutting had little effect on the appearance of East African freshwater fish stored in ice.
- (b) There was a definite deterioration in the quality of fish left un-iced for 6 hours on the deck of the boat before icing. Similarly Meynel (in press) found that fish from Lake Malawi left un-iced became unacceptable 5 to 7 hours after capture. Examination of the '6' h fish showed that, after 2 days' iced storage, the body lost some of its firmness and fresh seaweedy odour and, when cooked, the texture of the flesh was very soft. This difference in quality was quite pronounced throughout the iced trial and, while the 'O' h fish was still rated as quite acceptable by the taste panel after 14 days' storage, the '6' h fish was rated as poor even after 2 days' storage and reached the limit of acceptability after 14 days.
- (c) A consistent difference in quality between large and small vara-vara was noticed during iced storage. The larger fish were invariably of better appearance and were still acceptable after 20 days' storage (although, when cooked, they had a rather tough texture and no flavor), whereas the flesh of the small fish, when cooked, had an off-flavour, was extremely soft, and was judged by the taste panel as

unacceptable (score mark 3.5). Hoffman *et al.*, (1974) also found that size was an important factor in the spoilage of tropical freshwater fish.

Table 3

Physical changes in vara-vara stored in ice

Days in ice	Observation	Gutted/Un-gutted	Iced immediately ('O' h)/ Iced after 6 hours ('6' h) (Fish gutted and gilled)	Large fish/Small fish
		<i>Gutted</i>	<i>'O'h</i>	<i>Large</i>
1	General appearance	Eyes slightly opaque; gills red	Eyes black pupil, translucent cornea; body shiny	Eyes black pupil, translucent cornea; body thin, slime; gills pink/red
	Raw odour	Seaweed	Seaweed	Seaweed
	Gut cavity	Seaweed odour	Pearly white	Pearly white
	Texture	Firm	Firm	Firm
		<i>Un-gutted</i>	<i>'6'h</i>	<i>Small</i>
	General appearance	As above	Eyes black pupil, translucent Cornea; body glossy, some slime	As above
	Raw odour	As above	Fresh celery	As above
	Gut cavity	As above	Some pinkness	As above
	Texture	As above	Slightly loose	As above
2		<i>Gutted</i>	<i>'O'h</i>	<i>Large</i>
	General appearance	Eyes slightly opaque; gills red/pink, some slime	Eyes black pupil, translucent cornea; body glossy, some slime	Eyes black pupil, translucent cornea; body sheen; gills pink, some slime
	Raw odour	Seaweed	Seaweed	Seaweed
	Gut cavity	No off-odour	Pearly white	Pearly white
	Texture	Firm	Firm, elastic	Firm, elastic
		<i>Un-gutted</i>	<i>'6'h</i>	<i>Small</i>
	General appearance	Eyes slightly opaque; body sheen; gills dark red, slime, seaweed odour	Eyes grey; body loss of sheen	As above

Raw odour	Seaweed	Fresh celery	As above
Gut cavity	Slightly soft	Slightly pink	As above
Texture	Firm	Loss of elasticity	As above

6

	<i>Gutted</i>	<i>'O' h</i>	<i>Large</i>
General appearance	Eyes getting cloudy; gills pink/brown, copious slime, body sheen	Eyes flat or swollen, pupil grey; body loss of sheen, discoloured	Eyes cloudy, concave; body some sheen; gills red, little slime
Raw odour	Seaweed	Fresh celery	Seaweed
Gut cavity	No off-odour	Some pinkness	Pearly white
Texture	Firm	Loss of firmness	Loss of elasticity

	<i>Un-gutted</i>	<i>'6' h</i>	<i>Small</i>
General appearance	Eyes cloudy; gills red/brown, copious slime; body sheen	Eyes flat and pupil grey; body discoloured	Eyes cloudy, concave; body some sheen; gills red/brown
Raw odour	Seaweed	Musty, earthy	Fresh celery
Gut cavity	Soft areas	Distinct pinkness	Some pinkness, faint off-odour
Texture	Firm	Soft, loose	Some softening

10

	<i>Gutted</i>	<i>'O' h</i>	<i>Large</i>
General appearance	Eyes flat or sunken, cloudy; gills copious slime, discoloured, sweet off-odour	Eyes flat or sunken, cloudy; scales lifting; discoloration	Eyes cloudy, concave; body sheen; gills red/brown, patchy, some slime
Raw odour	Seaweed	Stale celery	Celery
Gut cavity	No off-odour	Some pinkness	Pearly white/pink
Texture	Loss of elasticity	Firm — due rigor	Some softening
	<i>Un-gutted</i>	<i>'6' h</i>	<i>Small</i>
General appearance	Eyes flat or sunken, cloudy; gills brown, copious slime, sweet off-odour	Eyes sinking; body discoloured	Eyes pupil cloudy, concave; body bleached in places; gills brown, copious slime

	Raw odour	Seaweed	Slightly musty	Celery
	Gut cavity	Soft	Pronounced pinkness	Pink colour, no off-odour
	Texture	Loss of elasticity	Soft	Quite soft, scales lifting
14		<i>Gutted</i>	<i>'O'h</i>	<i>Large</i>
	General appearance	Eyes sunken, cloudy; gills pink, sweet odour; scales lifting	Eyes sunken, cloudy; body discoloured; scales lifting	Eyes cloudy, sunken, orange/red pupil; body some belaching; gills brown, slimy
	Raw odour	Neutral	Turnipy/musty	Turnipy
	Gut cavity	Slight off-odour	Pink, turnipy odour	Pink, off-odour
	Texture	Loss of elasticity	Passing through rigor	Soft
		<i>Un-gutted</i>	<i>'6'h</i>	<i>Small</i>
	General appearance	Eyes sunken, cloudy, gills	As above	As above
	Raw odour	Neutral	As above	As above
	Gut cavity	Soft	As above	As above
	Texture	Loss of elasticity	Very soft	As above
17		<i>Gutted</i>	<i>'O'h</i>	<i>Large</i>
	General appearance	Eyes sunken, cloudy; gills discoloured, strong sweet off-odour	Eyes sunken, cloudy; body bleached; scales lifting	Eyes cloudy, sunken; body bleached; gills brown, slimy
	Raw odour	Turnipy off-odour	Turnipy, musty	Turnipy
	Gut cavity	Off-odour	Pinkness, turnipy odour	Pinkness, off-odour
	Texture	Loose	Soft	Soft
		<i>Un-gutted</i>	<i>'6'h</i>	<i>Small</i>
	General appearance	As above	As above	As above
	Raw odour	Neutral	Musty	Musty
	Gut cavity	Very soft	As above	As above
	Texture	As above	As above	As above

20

	<i>Gutted</i>	<i>'O' h</i>	<i>Large</i>
General appearance	Eyes sunken, cloudy; gills discoloured, off-odour; body matt	Eyes sunken, cloudy	Eyes cloudy, sunken; body bleached; gills pale red, slimy
Raw odour	Turnipy	Turnipy	Turnipy
Gut cavity	Off-odour	Very pink	Pink, strong odour
Texture	Loose	Becoming soft	Soft, little elasticity
	<i>Un-gutted</i>	<i>'6' h</i>	<i>Small</i>
General appearance	As above	Eyes very sunken; body discoloured	Eyes brown, sunken, bloodshot; body bleached; gills brown and slimy
Raw odour	As above	As above	Musty
Gut cavity	Soft	Red	As above
Texture	As above	Very soft	As above
	END OF TRIAL	END OF TRIAL	

23

	<i>Large</i>
General appearance	Eyes sunken; body bleached; gills brown, strong off-odour, slime
Raw odour	Turnipy — celery
Gut cavity	Pink
Texture	Soft
	<i>Small</i>
General appearance	Eyes sunken; body bleached; gills white, bleached
Raw odour	Celery
Gut cavity	As above
Texture	As above

27

Large

y

General appearance

Eyes sunken or bulging, blood-shot; body bleached, bulging; gills brown, slime

Raw odour

Musty

Gut cavity

Pink, off-odour

Texture

Very soft

Small

AS FOR LARGE

END OF TRIAL

- (e) Vara-vara were stored in ice for 2, 7 and 14 days and then smoked and submitted to a taste panel. All the products were rated as 'good' although, at 14 days, the texture was slightly tough.
- (f) Smoked fillets of vara-vara, glazed and unglazed, were stored in polythene bags for 3 months, at -10°C and -40°C , and then submitted to a taste panel. The loss of weight was of the same order for the glazed and unglazed fish and amounted to 0.2 percent for -40°C storage and 0.7 percent when the fish were stored at -10°C . There was a very slight preference for fish that were glazed and then stored at -40°C . All the other treatments (unglazed and stored at -40°C ; glazed and unglazed and stored at -10°C) gave products which attracted high taste panel scores.
- (g) After brining, fillets of vara-vara were allowed to hang in a chill room for half an hour and 24 hours before smoking. A visual examination of the fish revealed no difference in colour and appearance between the treatments, and the taste panel scores were of the same order for both products. There is no advantage, therefore, in hanging the fish overnight before smoking, as practised by some fish curers in Seychelles.

FISH CAKES

Some preliminary work was carried out with the aim of utilizing the mince obtained from fish frames and of upgrading shark meat which has a low consumer appeal and a low market value (U.S.\$ 0.25/kg) in Seychelles.

A number of fish cakes were prepared in which:

- (a) the ratio of fish to the filler material, such as sweet potato, was varied;
- (b) the ratio of shark flesh to minced vara-vara flesh was varied.

The products were then submitted for taste panel assessment and the cost of the raw materials for the different products was assessed. It was found that the following products obtained the highest taste panel scores:

- (a) Shark/vara-vara (1:1)
- (b) Shark/vara-vara/sweet potato (1:1:1)
- (c) Shark/vara-vara/sweet potato (2:1:1)

The preferences depended, to some extent, on whether or not the person tasting the cakes liked the taste of the sweet potato. The cost of the raw materials for a pure shark cake, 75 g in weight, before it is breaded, is U.S. \$ 0.04. Because the price of shark and sweet potato is the same in Seychelles, when shark is substituted by sweet potato, the cost remains the same. A shark/vara-vara/sweet potato cake would cost slightly more due to the higher market value of vara-vara. If vara-vara flesh could be replaced by mince recovered from processed frames, one would expect that the price of the raw materials could be reduced quite substantially. It is intended to carry on with this development work, in particular, with the aim of utilizing fish mince obtained from the meat/bone separator. The Tropical Products Institute in London has been undertaking similar work for some years (Poulter and Disney, 1978).

FISH SILAGE

Heads of vara-vara were chopped into small pieces and minced together with the frames. Duplicate 500 g portions of the mince were weighed out into beakers and treated as follows:

- (a) 3 percent (volume to weight) formic acid added to the mince
- (b) 2.5 percent (volume to weight) formic acid added to the mince
- (c) 2 percent (volume to weight) formic acid added to the mince
- (d) 1 percent formic acid added in addition to 42 ml of 50 percent concentrated sulphuric acid; pH of the mixture 2.0

- (e) 1 percent formic acid added in addition to 25 ml of 50 percent concentrated sulphuric acid; pH of the mixture 2.5
- (f) 1 percent formic acid added in addition to 20 ml of 50 percent sulphuric acid; pH of the mixture 3.0

The beakers were covered with aluminium foil and examined periodically. After one month's storage, silages (e) and (f) developed strong off-odours and were discarded.

Table 4
Torryster readings and taste panel scores of vara-vara stored in ice

Days in ice	Taste panel score					
	Gutted fish	Un-gutted fish	Iced immediately	Iced after 6 hours	Large fish	Small fish
2			8.0	5.6	—	—
6	9.0	9.0	7.6	5.5	—	—
10			—	—	—	—
14	7.0	6.5	6.8	4.7	—	—
20	6.3	6.0	3.5	1.0	5.5	3.5
27					2.0	1.0

Total volatile base (TVB) assays using Conway diffusion method (Beatty and Gibbons, 1937) were carried out on the iced fish and the results are given in Table 5. Each TVB assay was carried out in duplicate. Although there is no strict correlation between TVB values and taste panel scores, the limited data on TVB content suggest that vara-vara, giving a TVB value of between 25 and 30 mg/100 g, may be referred to as stale and has reached the limit of acceptability. More TVB assays on iced vara-vara are required in order to establish a TVB value which corresponds to qualities associated with spoilt fish. However, it may be noted that other workers (Amu and Disney, 1973; Poulter *et al.*, 1978) found difficulty in correlating taste panel and TVB results due to the variable nature of the latter.

Table 5
TVB (mg/100 g) of vara-vara stored in ice

Days in ice	Gutted fish	Iced immediately	Iced after 6 h on deck	Small fish	Large fish
2	—	12	16	—	—
7	18	22	22	—	—
14	22	20	19	—	—
22	—	34	48	33	45
28	—	—	—	60	51

FROZEN STORAGE

As part of the programme on fish smoking, 6 vara-vara were taken; 3 were slow-frozen and 3 were quick-frozen. These were glazed and stored for 3 months at -10°C . The fish were examined visually before smoking and the observations are given in Table 6.

This preliminary study showed that slow-freezing and storage for 3 months at a high frozen temperature (-10°C) resulted in unfavourable changes such that the product was of unacceptable quality.

Table 6

Appearance of vara-vara stored at -10°C for 3 months

	Slow-frozen	Fast-frozen
Eyes	sunken, opaque	flat, opaque
Gills	brown, off-odour	no off-odour
Body	discoloured, soft	very slightly discoloured
Gut cavity	slight off-odour	no off-odour
Fillet	very soft, discoloured, faint off-odour	white, no off-odour

SMOKED PRODUCTS

An investigation into the factors which might affect the quality of smoked vara-vara was carried out. The following variables were investigated:

- Kind of sawdust used
- Skinless versus skin-on smoked products
- Use of spiced brine
- Effect of freezing prior to smoking
- Effect of iced storage
- Cold storage of smoked products
- Different hanging times after curing

In general, vara-vara make an excellent smoked product and, when 7 different smoked species were submitted to a taste panel, vara-vara was rated very highly; a few members of the taste panel liked it as much as smoked salmon. The conclusions of the above investigation are summarized below:

- Sawdust from local timbers (*Albizzia*, *Santol* and *Albizzia* with 20 percent cinnamon bark added) were used to smoke vara-vara. Very few members of the taste panel could detect the cinnamon flavour in the smoked fish. Most people preferred the slightly stronger flavour of the vara-vara which was smoked using *Albizzia*-cinnamon bark mixture, but the preferences for any particular treatment were only very slight.
- Skin-on and skinless fillets were smoked and submitted to a taste panel for evaluation. The total yields (smoked product to whole fish) were 32 percent for the skin-on smoked fish and 25 percent for the skinless product. The taste panel preferred the skinless smoked fillets; besides having a better appearance, they were also easier to slice.
- Vara-vara, brined either in plain or in spiced brine, were smoked together and presented to a taste panel. The spiced brine contained, in addition to salt, black pepper and bay leaves. Both products were generally equally well liked, but two members of the taste panel did not like the peppery flavour of the smoked fish prepared in the spiced brine.
- Vara-vara, kept in ice for two days, were quick-frozen or slow-frozen. They were then cured and smoked on the same occasion and submitted to a taste panel. It was found that the members of the

taste panel could not detect any real difference between the treatments. It was found, however, in a subsequent trial, that slow-freezing and subsequent storage at a high storage temperature (-10°C) for 3 months does lower the quality of the frozen fish and the smoked product made from it.

Silage (d) was showing signs of putrefaction after two and a half months and product (c) after 3 months. Silages (a) and (b) did not show any signs of spoilage after 9 months.

Silage was semi-liquid, with some skin but no bones apparent, and had a not unpleasant acid odour. A bacteriological assay on (a) showed that it was sterile. It was shown in the Solomon Islands that a type of fish silage could be used successfully for pig feeding (Disney *et al.*, 1978). The cost of formic acid in Seychelles would be in the order of U.S.\$ 860 c.i.f. per tonne. Therefore, the cost of acid in order to produce silage (b) would be U.S.\$ 2.20 per 100kg. The protein content could be of the order of 20 percent. Therefore, the cost of acid to make an amount of silage which would provide the same amount of protein as commercial fish meal (60 percent), would be U.S.\$ 66 per tonne (excluding labour and equipment costs). For comparisons the cost of imported pig feed in Seychelles is approximately U.S.\$ 300 per tonne.

CONCLUSION

The investigations described in this paper represent the first step toward solving some of the post-harvest development problems in the Seychelles. The snapper, *Lutianus bohar*, is a potentially important species to the Seychelles small-scale industry but it is grossly underutilized and, indeed, wasted because it is considered a second-grade fish both by traditional consumers and by customers in certain importing countries, particularly those where this same species is prone to ciguatera poisoning.

The information gathered so far indicates that it should not be difficult to improve the utilization and marketing of *L. bohar* caught in the Seychelles provided the fish are iced immediately after catching to ensure freshness. Further investigations are obviously needed. Nevertheless, from a purely technological viewpoint, it appears that *L. bohar* should be processed into higher value products such as smoked fillets or spiced cakes which ought to obtain good consumer acceptance. After filleting, the carcasses could be put through a bone/meat separator to obtain additional minced material for incorporating into fish cakes. The waste could then be utilized for silage production.

REFERENCES

- Amu, L. and J.G. Disney, Quality changes in West African marine fish during iced storage. *Trop.Sci.*, 15(2): 1973 25-38
- Beatty, S.A. and N.E. Gibbons, The measurement of spoilage in fish. *J.Biol. Board Can.*, 3(1):77-91 1937
- Disney, J.G., W.H. Parr and D.J. Morgan, Fish silage: preparation, utilization and prospects for development. 1978 Symposium on fish utilization, technology and marketing in the IPFC region. Manila, Philippines, 8-11 March 1978
- Hoffman, A., J.G. Disney, A. Pinegar and J.D. Cameron, The preservation of some East African freshwater fish. *Afr. J. Trop. Hydrobiol. Fish.*, 3(1):1-13 1974
- Meynell, P. J., The effect of different handling procedures upon the quality of frozen chesawasawa from Lake Malawi during both hot and cold seasons. *Trop.Sci.* (in press)
- Poulter, R.G. and J.G. Disney, Development of novel products from tropical fish species. Paper presented at 2nd 1977 Annual Tropical and Subtropical Fisheries Technology Conference of the Americas. Biloxi, U.S.A. 1977
- Poulter, R.G., L. Nicolaides and D. Hector, Quality changes in fish from the South China Sea: iced storage of 1978 chub mackerel, grouper and fusilier. Symposium on fish utilization, technology and marketing in the IPFC region. Manila, Philippines, 8-11 March 1978

QUALITY CHANGES IN FISH FROM THE SOUTH CHINA SEA: ICED STORAGE OF CHUB MACKEREL, GROUPER AND FUSILIER

by

R.G. Poulter, Linda Nicolaides and D.A. Hector
Tropical Products Institute
London, U.K.

Abstract

Quality changes during storage in ice were investigated in three commercially important fish from the South China Sea. Physical and organoleptic examination showed that chub mackerel (*Rastrelliger brachysoma*) and fusilier (*Caesio cuning*) were acceptable for up to two and a half weeks and grouper (*Plectropoma maculatum*) for four weeks. Measurement of nucleotide and total volatile base concentrations largely confirmed these finds but are unlikely, on their own, to be reliable quality indices. At the limit of acceptability, the bacterial counts of the flesh and skin (10^6 - 10^7 organisms per cm^2 skin or g of flesh) were lower than would be expected for temperate species.

INTRODUCTION

Ice is very widely used in the more developed parts of the world to maintain the quality of fresh fish. The increase in shelf life that is brought about by storing cold- and temperate-water fish in ice has been well researched, documented and publicized (Bramsnaes, 1965). Furthermore, much research effort has been expended in developing methods for assessing the quality of these fish (Connel, 1975).

In the developing tropical countries the situation is very different. Only relatively recently has the use of ice or the application of ice or the application of refrigeration been introduced and neither is widespread. The losses that occur through not using ice are difficult to quantify but they must be extremely high. It is ironic that in many cases the greatest losses occur in countries with the lowest *per caput* intake of protein.

The use of ice is possibly the simplest method of preserving the fish catch and benefits in the tropics are perhaps even greater than in the colder zones. Stored at ambient temperatures, the acceptable shelf life of fish in the tropics is shorter than for fish from cooler climates but the available evidence suggests that the shelf life of tropical fish, stored in ice, may be up to twice as long as that for cold- or temperate-water fish (Disney, 1976).

It is only in recent years that fish technologists have realized that the technology developed for use in cold- and temperate-water fisheries may not be appropriate for use in the tropics (Disney, 1976). The development of appropriate technology has also been hampered by the dearth of basic information on the spoilage characteristics of tropical fish.

The purpose of the present study was to determine the shelf life of three commercially important fish species from the South China Sea and to evaluate the usefulness, for tropical fish, of several objective quality tests which have been developed for cold- and temperate-water fish. This study complements similar studies carried out on Indian and West African marine species (Velankar and Kamasastri, 1956; Aldrin *et al.*, 1970; Nair *et al.*, 1971, 1974; Govindan, 1971; Amu and Disney, 1973).

MATERIALS

Chub mackerel (*Rastrelliger brachysoma* Bleeker), grouper (coral cod, *Plectropoma maculatum*, Block) and fusilier (yellow-tailed fusilier, *Caesio cuning* Block) were caught in the South China Sea off the coast of Brunei. The chub mackerel were caught by gillnet on 21 February 1976 and the grouper and fusilier in pots at a depth of 36 m on 30 June 1977. The fish were placed in ice as soon as possible after capture, re-iced in insulated boxes on landing at Bandar Seri Begawan by the Brunei Fisheries Department and sent by air freight to London. On arrival at the Tropical Products Institute (three days after capture) the fish were again re-iced (approx-

mately 1:1 fish to ice) and packed in insulated containers with provision for drainage of melt-water. The ice was topped up daily and renewed once a week. At two- to three-day intervals over a period of one month, fish (two specimens each of grouper and fusilier and five specimens of chub mackerel) were removed from the ice and samples were taken for bacterial counts. The fish were then filleted and suitable portions of fillet were put to one side for organoleptic analysis. After the dark muscle, skin and large pieces of connective tissue had been removed, the remaining fish was finally chopped with a scalpel and scissors. This finely chopped white muscle was maintained at 0°C until analyzed.

METHODS

Crude protein

This was determined on 2 g samples of fish muscle using the micro-Kjeldahl method (Bradstreet, 1965); total nitrogen content was converted to crude protein content by multiplying by a factor of 6.25 (Pearson, 1970).

Total lipid and peroxide values

The lipids contained in 20 g of flesh were extracted by the Blight and Dyer method (1959) using methanol and chloroform. The peroxide content of the extracted lipid was determined using potassium iodide and sodium thiosulphate (AOA, 1965) and expressed as milli-equivalents/kg lipid.

Thiobarbituric acid values (TBA)

The TBA values of duplicate 10 g samples of fish muscle were determined by the malonaldehyde distillation method of Tarladgis *et al.* (1960). The optical density of the final solution was determined at 538 nm using an SP 500 spectrophotometer. The values were expressed as mg/kg sample.

Water content

Approximately 10 g portion of fish muscle were placed in a convection oven maintained at 105°C and heated for 12 h. The weight loss was presumed to be entirely due to evaporation of water.

Ash

Fish muscle (3 g) was placed in a silica dish and charred using a bunsen burner. The charred sample was ashed in a muffle furnace at 525°C.

Total volatile bases (TVB)

Perchloric acid extracts were prepared from duplicate 3 g samples of muscle (Jones *et al.*, 1965). The TVB contents were estimated by a procedure based on the micro-diffusion method of Conway (Beatty and Gibbons, 1937) using sulphuric acid to absorb the liberated bases.

Nucleotides

Duplicate samples of fish muscle (2 g) were extracted with 20 ml of perchloric acid and hypoxanthine and other nucleotides were estimated using the TLC method of Norman *et al.* (1974).

Assessment of bacteriological load

Using a sterile template a representative area of skin was aseptically removed (25 cm² — fusilier and grouper cm² — chub mackerel) and placed inside a sterile stomacher bag. Peptone water (100 ml — fusilier and

grouper; 50 ml — chub mackerel) was added and the contents were macerated in a Colworth stomacher for min. This suspension constituted the initial dilution.

Samples of flesh were removed (5 g — chub mackerel; 10 g — fusilier; 25 g — grouper) and placed in a sterile stomacher bag together with a quantity of peptone water which resulted in a 10^{-1} dilution (45 ml — chub mackerel; 90 ml — fusilier; 450 ml — grouper). This suspension, after being 'stomached' for 1 min, constituted the initial dilution.

Tenfold dilution series were made from the initial dilutions, in sterile universal containers, using 9 ml quantities of peptone water as the diluent. Two sets of pre-poured plates (plate count agar) were inoculated with 0.1 ml of the appropriate dilution. Duplicate plates of each dilution were prepared for each set. One set of plates was incubated at 4°C and the other at 27°C. The number of colonies which had grown after 3 (27°C) and 14 (4°C) was recorded.

pH

Fish muscle (2 g) was homogenized in 10 ml of neutralized 0.005 M iodoacetic acid. The pH was measured at room temperature with a Radiometer 26 pH meter using a glass electrode. Each determination was performed in duplicate.

Taste panel

Portions of skinless fillet weighing approximately 25 g were sealed in nylon pouches and cooked in boiling water for 30 min. The taste panel, consisting of four to six experienced judges, was asked to give the samples an overall acceptability score; 10 being good, 1 being bad, 4 being just acceptable.

Physical examination

At intervals during the storage period each fish species was examined for signs of quality deterioration. Particular attention was paid to the appearance of the eyes and skin, the colour and odour of the gills and the firmness of the flesh.

Objective physical quality assessment

A GR-Torry meter was used (Gr-International Electronics Ltd., Camberley, England). The dielectric properties of fish tissue change progressively during post rigor storage. The Torry meter responds to the dielectric changes and is claimed to provide an accurate measurement of the freshness of fish. For each assessment, four fish were taken and four readings made of each fish. The 16 readings thus obtained were averaged electronically by the instrument and read off directly.

RESULTS AND DISCUSSION

The weight of the fish and their proximate composition are given in Table 1. The weight of the fish, particularly the grouper and fusilier, was quite variable (i.e., a factor of 3 between the largest and smallest) but it is inevitable that there will be size variation when working with fish caught by small-scale artisanal fishermen.

Despite the fact that chub mackerel is termed a fatty fish the lipid content of the flesh was relatively low. The lipid and water contents of fatty fish vary inversely throughout the year and the mackerel studied here must be considered to be 'lean' specimens. Unlike chub mackerel, which is a pelagic fish, grouper and fusilier are demersal fish and their flesh lipid contents were less than one percent.

The quality of the fish was assessed at intervals during iced storage by physically examining the whole fish

and by tasting portions of cooked fillet. Although both methods are subjective in nature, they are in the long run perhaps the most important methods of determining quality since it is on the basis of such assessments that the consumer accepts or rejects the fish. The results (physical examination, Table 2; taste panel, Fig. 1) indicate that grouper remained acceptable for about four weeks whereas fusilier and chub mackerel remained acceptable for only two and a half weeks. For comparable cold-water fish species, e.g., cod (*Gadus morhua*) a large demersal fish and mackerel (*Scomber Scombrus*) a small pelagic fish, the acceptability life in melting ice would be about two and one week respectively (Bramsnaes, 1965; Stansby and Lemon, 1941). The results therefore confirm the conclusion of other investigators (Disney, 1976) that tropical fish have a much longer shelf life in ice than cold-water species. It is not clear why the fusilier and grouper, two demersal fish of similar fat content, should have such different shelf life. It may be that the size of the fish is important (Hoffman *et al.*, 1974) but no systematic study has been made.

As fish spoil, there is a progressive breakdown of the flesh constituents as a result of the action of endogenous enzymes and the growth of bacteria. The study showed that the bacterial population on the skin increased gradually during the first two weeks of storage (Fig. 2 and 3), from $10^3/\text{cm}^2$ skin (27°C) to 10^5 bacteria/ cm^2 skin (27°C) on chub mackerel and fusilier and to 10^6 bacteria/ cm^2 (27°C) on grouper. After this the counts reached a plateau around 10^7 bacteria/ cm^2 skin (27°C) for the three species examined. This is probably due to a washing effect of the melting ice which removed a proportion of the bacteria from the skin surface.

Invasion and growth of bacteria in the muscle tissue of tropical fish is slow (Fig. 2 and 3). After one week's storage in ice the flesh was found to be virtually sterile in all three species. Then followed a steady increase to between 10^6 and 10^7 bacteria/g after 3-4 weeks. This is very different from results obtained with ice-stored temperate fish where a bacterial load of around $10^8/\text{g}$ is reached within 10 to 14 days (Shewan, 1971).

At the beginning of the storage trial, the number of bacteria able to grow on plates incubated at 4°C was lower than the number of bacteria which grew on plates incubated at 27°C . After six days' storage in ice the number of bacteria monitored at 27°C showed a slight decrease. At this point it is probable that the species which were present in the original skin flora could not tolerate the low storage temperatures (0°C) and were eliminated. After about one and a half weeks' storage in ice, counts monitored at both 4°C and 27°C were virtually the same. This shows that psychrophilic bacteria were now predominant.

Various chemical and physical tests have been suggested as objective means of assessing fish quality but, as with many other aspects of fisheries research, most of them have been developed for use with cold- or temperate-water species. Several potential quality control dices were investigated in the present study.

The degradation of fish flesh during spoilage results in a gradual increase in volatile bases, mainly di- and trimethylamine and ammonia. TVB values of 30-40 mg percent have been suggested as the limit of acceptability for temperate- and cold-water fish (Connel, 1975). The TVB results for the three species studied here are shown in Fig. 4. For grouper and fusilier the values varied between 10 and 35 mg percent but there appeared to be no upward trend during storage. For chub mackerel, on the other hand, the values started at 15-20 mg percent and gradually rose to 55 mg percent after four weeks. It is interesting to note that the 30 mg percent level was reached after two and a half weeks of storage, i.e., at the point of incipient spoilage. If the TVB results of the three species studied here are considered with other studies carried out by the Tropical Products Institute (Amu and Disney, 1973; Hoffman *et al.*, 1974; Maynell, *in pres*), the results for 11 species are available. Of these, measurement of TVB appeared to be a useful index of quality in only four species. The reason for the absence of any significant change in TVB values in the majority of tropical fish species examined is not clear.

The changes in pH during iced storage of the three fish species under investigation in the present study are shown in Fig. 5. The pH of grouper rose by approximately 0.5 of a pH unit, that of fusilier by 1 pH unit and that of chub mackerel by 1.5 pH units. Although the pH of fish muscle can be affected by a great many post mortem biochemical reactions, it is surprising that such relatively large pH increases in grouper and fusilier were recorded without a concomitant rise in TVB. Although the initial post rigor pH of fish muscle varies considerably, depending on the nutritional state of the fish, degree of struggling prior to death, etc., the changes in the muscle

pH of the three species studied here correlated with the taste panel scores more closely than any of the other objective quality assessment methods.

The estimation of hypoxanthine (Hx) has also been proposed as a measure of fish freshness (Jones *et al.*, 1964). Hypoxanthine is formed in fish muscle mainly as a result of autolytic degradation of adenosine triphosphate (ATP). However, the last step in the pathway, inosine to hypoxanthine can be brought about by both autolytic and bacterial enzymes (Jones, 1966). Fig. 6 shows the inosine monophosphate, inosine and Hx levels in grouper, fusilier and chub mackerel at intervals during one month's storage in ice. The Hx content of chub mackerel increased in a regular manner during the first three weeks of storage but dropped slightly in the last week. Grouper and fusilier, on the other hand, had much lower initial Hx levels but they showed a slight upward trend during storage. At the point of incipient spoilage, the Hx levels were between 1.2 and 1.5 moles/g for grouper, 1.0 and 1.3 moles/g for fusilier and 9.3 and 10.3 moles/g for chub mackerel. In grouper and chub mackerel, this point also corresponds to the maximum level found during storage. The levels of Hx have been found to differ widely between four West African marine species (Amu and Disney, 1973). These authors also found that different sized fish of the same species had different Hx contents but concluded that the measurement of hypoxanthine was potentially useful as a quality test. The results of the present study, shown in Fig. 6, indicate a different mode of ATP degradation in grouper and fusilier compared with chub mackerel but further work is required to determine whether this difference is real and what effect it would have on the usefulness of Hx measurement as a means of assessing fish quality.

An estimate of the degree of rancidity in the fish during storage in ice was obtained by measuring the malonaldehyde content (TBA value) for grouper and fusilier and the peroxide value for chub mackerel (Table 3). Grouper and fusilier are lean fish and, although the TBA values showed a high degree of variation, they were generally low and did not reach the level of 1.80 mg/kg which has been designated the 'just spoiling' value for beef (Pearson, 1968). The peroxide values for chub mackerel are more difficult to evaluate. First, peroxides are intermediate lipid degradation products which build up initially during storage and then decline. This also means that very rancid materials may have low peroxide values. Second, peroxide values are always quoted as milli-equivalents/kg fat. Just spoiling values of 10-20 m equivalents/kg fat, depending on the type of fat, have been suggested (Pearson, 1970). This is the range of values at which the fat itself tastes rancid. It does not mean that when distributed throughout the flesh of fish at a concentration of 1 or 2 percent, as in chub mackerel, the flesh itself will taste rancid. However, during the first 2-3 weeks of storage in ice, there was a steady build-up of peroxides in the chub mackerel flesh and this must be a factor contributing to the decrease in taste acceptability.

The Torry meter readings for the three species are shown in Fig. 7. In grouper the readings fell progressively from a value of 14 after three days in ice to a value of 6 at the point of incipient spoilage, i.e., after 28 days in ice. This corresponds fairly well to the taste panel's results and, although the time scale is different, the range in values is similar to that obtained for cod (Cheyne, 1975). Amu and Disney (1973) also found that the Torry meter worked well for sea bream, a West African marine species. For the other two species studied in the present work, the change in values with time was very small and, particularly for chub mackerel, the readings were very low. Compared with other objective methods of measuring fish quality the Torry meter has the advantage of being simple to operate, providing a rapid result and the sampling is non-destructive. The present results indicate that many more data, particularly with tropical species, must be collected before the true worth of the Torry meter can be assessed as a reliable means of evaluating fish quality.

CONCLUSIONS

Storage in ice under laboratory conditions has been found to give a storage life for 3 fish species from the South China Sea of between two and a half and four weeks. Although this period would be reduced under commercial conditions it should still be sufficient to permit capture, storage and transport, over considerable distances. This, of course, requires ice to be widely available which, unfortunately, is often not the case. Nonetheless, this and other similar studies indicate the particular benefits to be gained from storing tropical fish in ice and, hopefully, will encourage the introduction of more ice plants and refrigerated holding facilities in the developing world.

A number of subjective and objective quality assessment tests have been considered. Simple tests to determine changes in taste acceptability and physical appearance were found useful in determining quality and would be particularly suitable for routine quality assessment in developing countries. Of the objective methods studied, none was found to correlate perfectly with the taste panel results but several showed promise.

The bacterial numbers increased in a fairly regular manner during the storage period but the disadvantage of using total viable bacterial counts as a quality index is that by the time the results are available (3 or 4 days after sampling) the quality of the fish will have significantly changed. The results of microbiological examinations made in this study are particularly interesting; however, since they support earlier suggestions (Disney, 1976; Shewan, 1977) that the extended shelf life of tropical fish in ice, compared with temperate- or cold-water species, is due to the fact that the naturally occurring bacterial flora contain only a low proportion of psychrophilic bacteria.

Of the other objective methods, measurement of total volatile bases gave very variable results and, although the pH of the flesh of all three species increased in a fairly regular fashion, variation in initial pH between fish of the same species would probably make it unsuitable for use as a quality index. Measurement of rancidity is important in fatty fish such as chub mackerel but it has been shown that if the peroxide method is used the interpretation of single values must be treated with care. However, the TBA method did not prove to be a substantially better method of measuring rancidity in iced fish since the results obtained with grouper and fusilier were quite variable.

The Torry meter worked extremely well with grouper but, possibly because of their smaller size, not so well with the other two species. Experiments with this instrument should be undertaken on a wide range of tropical fish types and on different sizes of the same species. If it can be shown to be accurate and reliable it could provide a good method for assessing the quality of wet fish.

Hypoxanthine levels were found to correlate very well with taste panel results in one of the species examined but not so well in the other two. Again data for a much larger range of fish are required before definite conclusions can be drawn on the usefulness of Hx as an index of fish quality.

This investigation has added three more species to the list of tropical fish which have been the subject of iced storage trials. In relation to the number of commercially important fish species in the tropics, this list, though growing, is still extremely small. Furthermore, there is almost no published work on the effect of season of capture, plane of nutrition, etc., on the iced storage characteristics of tropical fish. This paper therefore ends with a plea to institutes involved in fishery research in the tropics to study the iced storage characteristics of fish which are commercially important in their countries and above all to publish the results.

ACKNOWLEDGEMENTS

The authors would like to thank Mr. R. Beales, Director of Fisheries, Brunei and his staff for assistance in obtaining the samples of fish.

REFERENCES

- Aldrin, J.F., C. Ambroggi and F. Pony Assemien, Le test de l'azote basique volatil applique a quelques especes 1970 de poissons tropicaux. *Rec. Med. Vet.*, 146(7):677-88
- Amu, L. and J.G. Disney, Quality changes in West African marine fish during ice storage. *Trop. Sci.*, 15(2):125-38 1973
- AOAC, Peroxide values. *In* Official methods of analysis. Washington, D.C., Association of Official Agricultural 1965 Chemists, p. 419 (10th ed.)

- Beatty, S.A. and N.E. Gibbons, The measurement of spoilage in fish. *J.Biol.Board, Can.*, 3(1):77-91
1937
- Bligh, E.G. and W.J. Dyer, A rapid method of total lipid extraction and purification. *Can.J.Biochem. Physiol.*,
1959 37:911-7
- Bradstreet, R.B., The Kjeldahl method for organic nitrogen. London, Academic Press
1965
- Bramsnaes, F., Handling of fresh fish. *In* Fish as food, edited by G. Borgstrom. London, Academic Press, Vol.
1965 4:1-63
- Cheyne, A., How the GR Torry meter aids quality control in the fishing industry. *Fish. News Int.*, 14(12):71-6
1975
- Connell, J.J., *In* control of fish quality. Fishing News (Books) Ltd., London, 179p.
1975
- Disney, J.G., The spoilage of fish in the tropics. Paper presented to the 1st Annual tropical and subtropical
1976 fisheries technology conference of the Americas, Corpus Christi, Texas, 1976
- Govindan, T.K., The problem of bleaching in iced fish. *Indian Food Packer*, 1971:21 p.
1971
- Hoffman, A. *et al.*, The preservation of some East African freshwater fish. *Afr.J.Trop.Hydrobiol.Fish.*, 3(1):1-13
1974
- Jones, N.R. *et al.*, Rapid estimation of hypoxanthine concentrations as indices of the freshness of chill stored
1964 fish. *J.Sci.Food Agric.*, 15:763 p.
- Jones, N.R., Observations on the relations of flavour and texture to monucleotide breakdown and glycolysis in
1966 fish muscle. *In* Proceeding of the 2nd International congress of food science and technology, Warsaw
- Mynell, P.J., The effect of different handling procedures upon the quality of frozen chisawasawa from Lake
Malawi during both hot and cool seasons. *Trop.Sci.* (in press)
- Nair, R.B., R.K. Tharamani and N.L. Lahiry, Studies on chilled storage of freshwater fish. I. Changes occurring
1971 during iced storage. *J.Food Sci.Technol. (India)*, 8:53-6
- Nair, R.B., Studies on chilled storage of freshwater fish. Factors affecting quality. *J.Food Sci. Technol.(India)*,
1974 11:118-22
- Norman, G.A., M.J. Follett and D.A. Hector, Quantitative thin-layer chromatography of ATP and the products of
1974 its degradation in meat tissue. *J. Chromatogr.*, 90:105-11
- Pearson, D., Application of chemical methods for the assessment of beef quality. Methods related to fat spoilage.
1968 *J.Sci.Food Agric.*, 19:553-6
- _____, The chemical analysis of foods. Churchill, London, p. 9 (6th ed.)
1970
- Shewan, J., The microbiology of fish and fishery products — a progress report. *J.Appl.Bacteriol.*, 34(2):299-315
1971

- , The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial action. In Proceedings of the conference on handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 51-67
- 1977
- Stansby, M.E. and Lemon, J.M., Studies on the handling of fresh mackerel (*Scomber scombrus*). Res.Rep.U.S. Fish.Wildl.Serv., (1):46 p.
- 1941
- Tarlagdis, B.G. *et al.*, A distillation method for the quantitative determination of malonaldehyde in rancid foods. J.Am.Oil Chem.Soc., 37:44-8
- 1960
- Velankar, N.K. and P.V. Kamasastri, The bacterial flora, trimethylamine and total volatile nitrogen of fish muscle at 0°C (in ice). Indian J.Fish., 3:269-89
- 1956

Table 1

Weight and proximate composition of grouper, fusilier and chub mackerel

GROUPER	Mean	Range	Number of replicates
Weight (g)	2,600	1,200-4,200	16
Crude protein (% w/w)	20.0	19.2-20.7	4
Total lipid (%w/w)	0.9	0.6-1.2	4
Moisture (% w/w)	78.5	77.5-78.8	4
Ash (% w/w)	1.1	0.9-1.4	4
FUSILLER			
Weight (g)	400	250-700	16
Crude protein (% w/w)	17.4	16.1-18.7	4
Total lipid (% w/w)	0.7	0.5-0.9	4
Moisture (% w/w)	79.2	78.4-80.2	4
Ash (% w/w)	1.0	0.8-1.3	4
CHUB MACKEREL			
Weight (g)	110	80-140	40
Crude protein (% w/w)	8.0	16.7-19-1	8
Total lipid (%w/w)	1.9	0.9-3.3	22
Moisture (% w/w)	78.2	76.5-18.2	8
Ash (% w/w)	1.2	1.1-1.4	4

Table 2

Physical changes in grouper, fusilier and chub mackerel during iced storage

Days in ice		Grouper	Fusilier	Chub mackerel
13/14	Eyes	Translucent	Sunken, opaque	Slightly opaque
	Gills	Pink, neutral odour, white mucus	Red, neutral odour white mucus	Pink-brown, neutral odour
	Flesh	Firm	Firm	Firm
	Skin	Bright	Bright	Bright
6	Eyes	Slightly sunken and opaque	Sunken, opaque	Slightly sunken and opaque
	Gills	Pink, neutral odour, white mucus	Red, neutral odour cream mucus	Red-brown, neutral odour
	Flesh	Firm	Firm	Firm
	Skin	Bright	Slightly dull	Slightly dull
10	Eyes	Slightly sunken, opaque	Sunken, white spot	Slightly sunken and opaque
	Gills	Red, neutral odour, some mucus	Red, neutral odour, clear mucus	Red-brown, fruity odour, some mucus
	Flesh	Firm	Firm	Firm
	Skin	Bright	Slightly dull	Dull
13/14	Eyes	Slightly sunken, opaque	Sunken, white spot	Sunken
	Gills	Red, slightly stale odour, mucus	Red, slightly stale odour, mucus	Light brown, strong fruity odour, mucus
	Flesh	Firm	Fairly firm	Slightly soft
	Skin	Bright	Dull, loose scales	Dull, loose scales
17/18	Eyes	Slightly sunken, opaque	Sunken, white spot	Sunken, opaque
	Gills	Red, sweet odour, mucus	Purple-red, strong sweet odour, mucus	Light brown, strong fruity odour, mucus
	Flesh	Fairly firm	Fairly firm	Soft
	Skin	Bright	Dull, slimy, loose scales	Discoloured, slimy, loose scales
20/21	Eyes	Slightly sunken, white spot	Sunken, white spot	Sunken, opaque
	Gills	Red, aromatic odour, mucus	Dark red, sweet odour, mucus	Light brown, putrid odour, mucus
	Flesh	Slightly soft	Slightly soft	Soft
	Skin	Fairly bright	Discoloured, loose scales	Discoloured, slimy, loose scales

Days in ice		Grouper	Fusilier	Chub mackerel
24/25	Eyes	Slightly sunken, white spot	Sunken, mucus	Sunken, opaque, splitting
	Gills	Red, putrid odour, mucus	Dark red, putrid odour, mucus	Brown, strong putrid odour, mucus
	Flesh	Slightly soft	Soft	Soft
	Skin	Dull, few loose scales	Discoloured, loose scales	Discoloured, slimy, loose scales
27/28	Eyes	Sunken, completely opaque	Swollen, yellow	Swollen, split
	Gills	Red, putrid odour, mucus	Dark red, putrid odour, mucus	Brown, strong putrid odour, mucus
	Flesh	Slightly soft	Soft	Soft
	Skin	Slightly discoloured, few loose scales	Discoloured, slimy, loose scales	Discoloured, slimy, loose scales

Table 3

Effect of storage in ice on the peroxide values of chub mackerel and TBA values of grouper and fusilier

Days in Ice	Peroxide values (milli equivalent/kg fat)		TBA (mg/kg)			
	Chub mackerel		Grouper		Fusilier	
	Mean	Range	Mean	Range	Mean	Range
3			0.48	0.43-0.53	0.42	0.41-0.44
4	33.3	25.0-41.8				
6	27.6	20.7-34.4	0.82	0.78-0.86	0.74	0.62-0.87
10	39.2	29.4-48.9				
11			0.32	0.27-0.39	1.10	0.82-1.37
13	52.1	49.9-54.3				
14			0.17	0.16-0.18	0.20	0.18-0.22
17	31.4	29.4-33.7				
18			0.15	0.13-0.18	0.26	0.23-0.30
20	57.0	46.4-67.5				
21			0.66	0.59-0.73	0.96	0.94-1.01
24	23.2	17.9-28.5				
25			0.47	0.46-0.48	0.61	0.60-0.62
27	20.6	20.4-20.7				
28			0.27	0.27-0.27	0.74	0.73-0.75

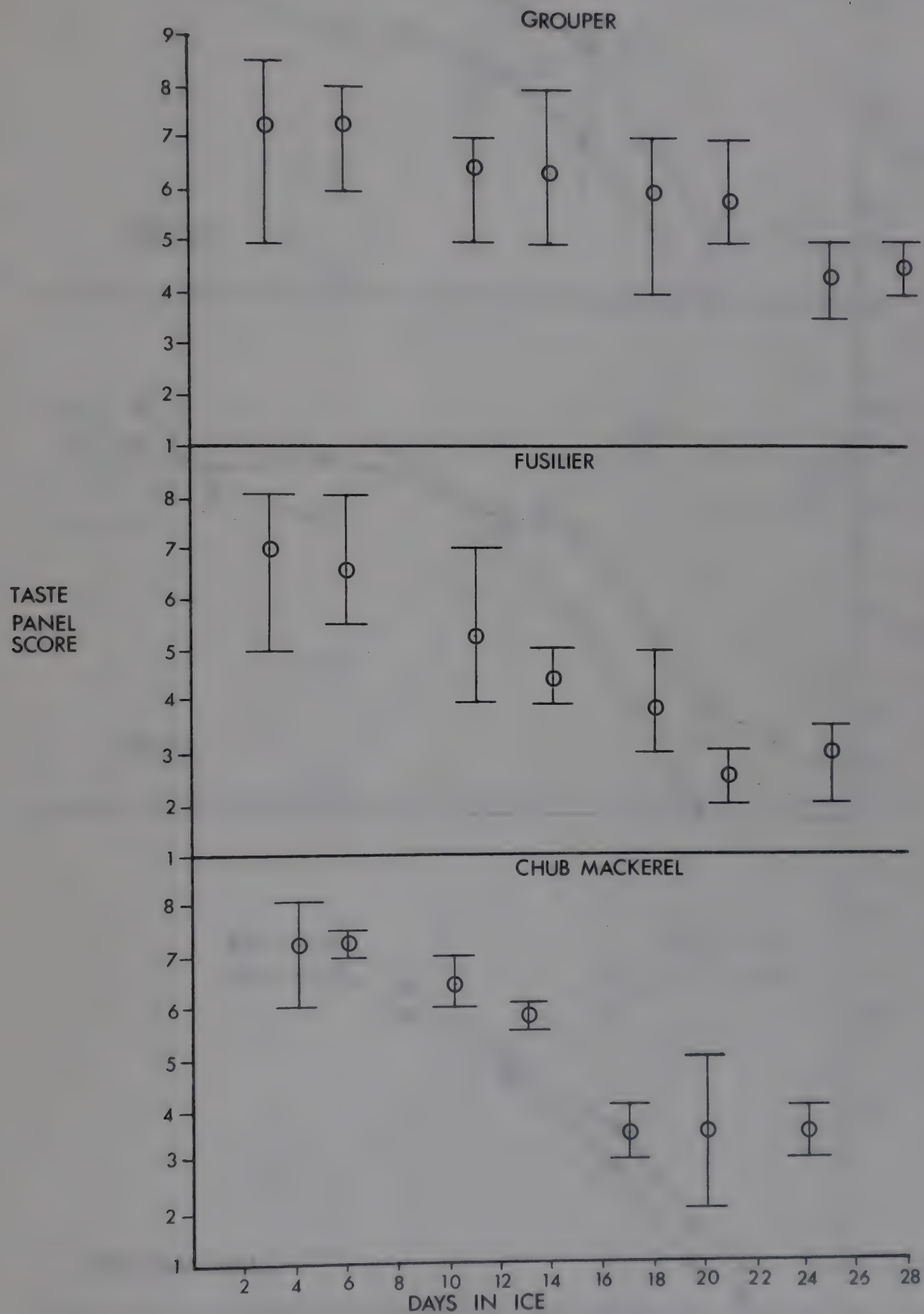


Fig. 1 -- The effect of storage in ice on overall taste panel scores.

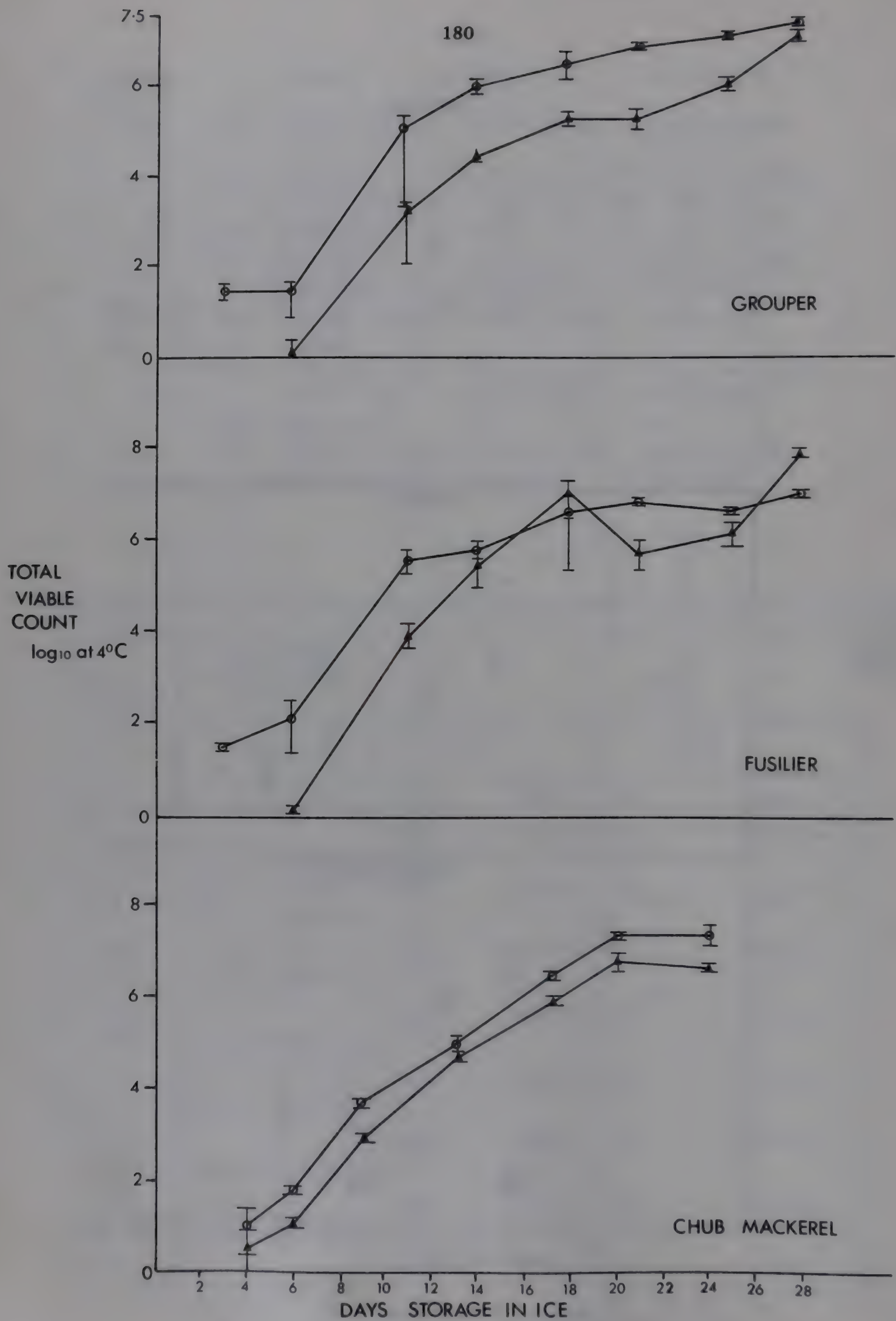


Fig. 2 — The effect of storage in ice on total viable counts of skin and flesh (4°C).

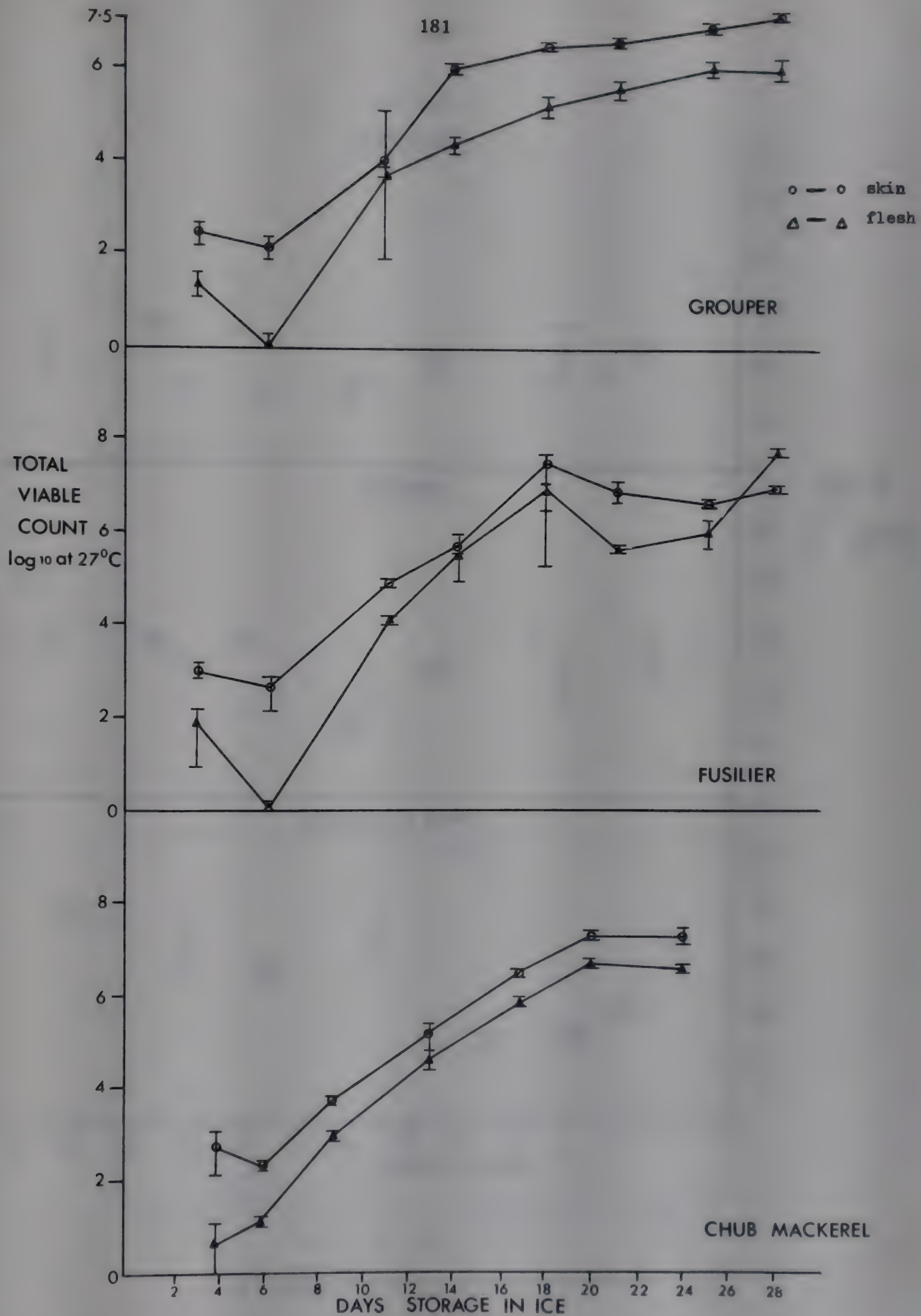


Fig. 3 — The effect of storage in ice on total viable counts of skin and flesh (27°C).

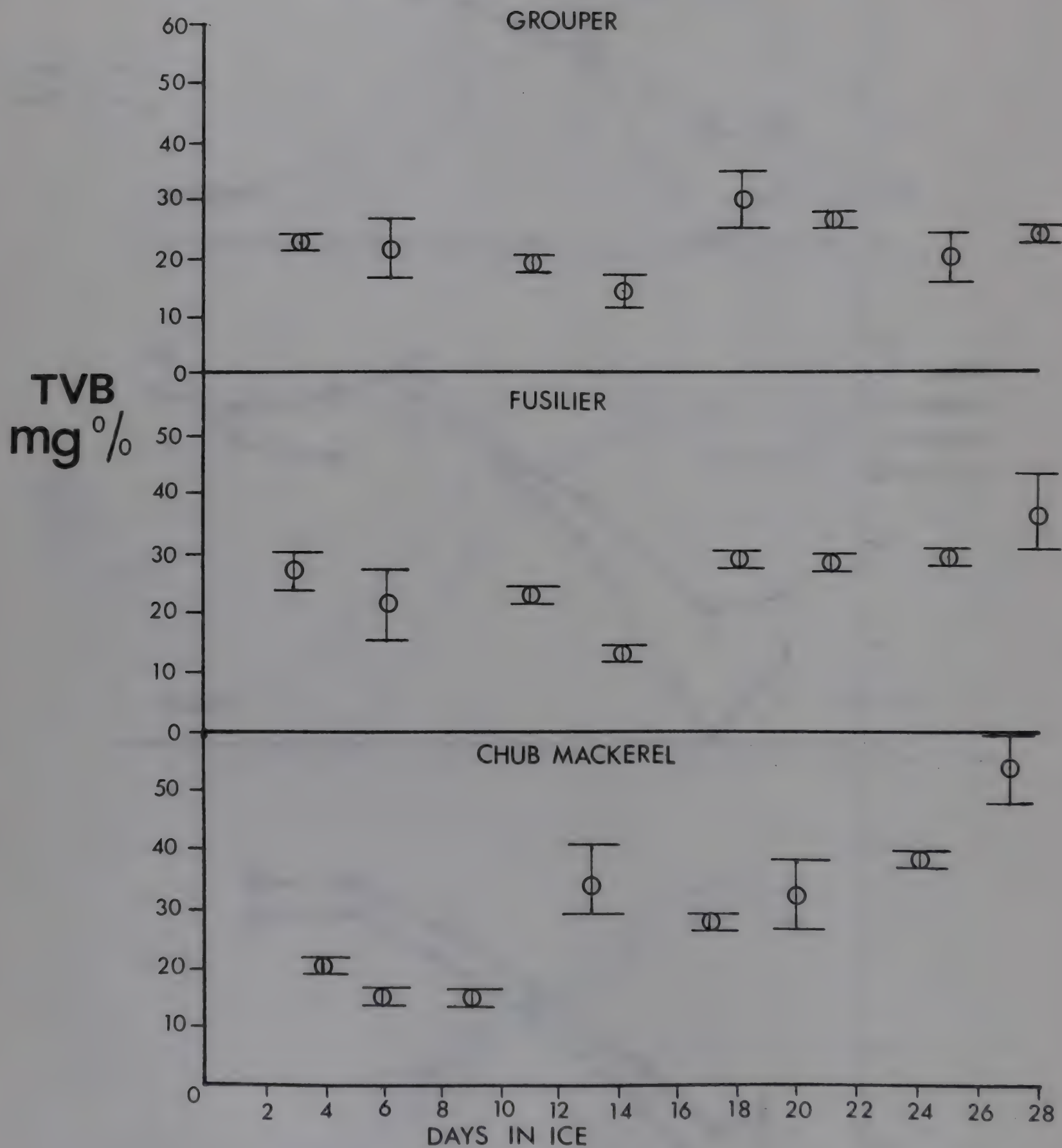


Fig. 4 - The effect of storage in ice on total volatile base (TVB).

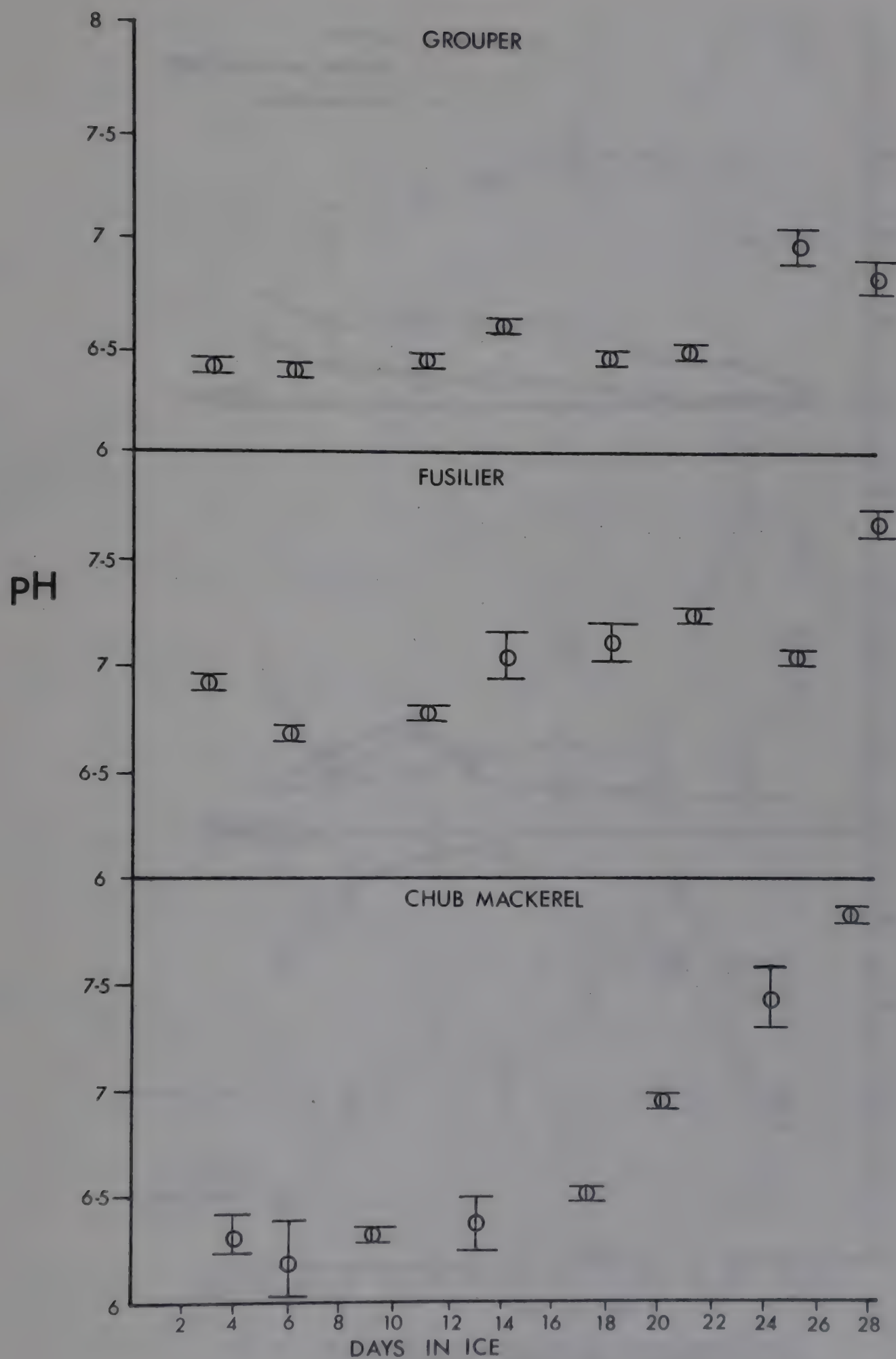


Fig. 5 - The effect of storage in ice on pH.

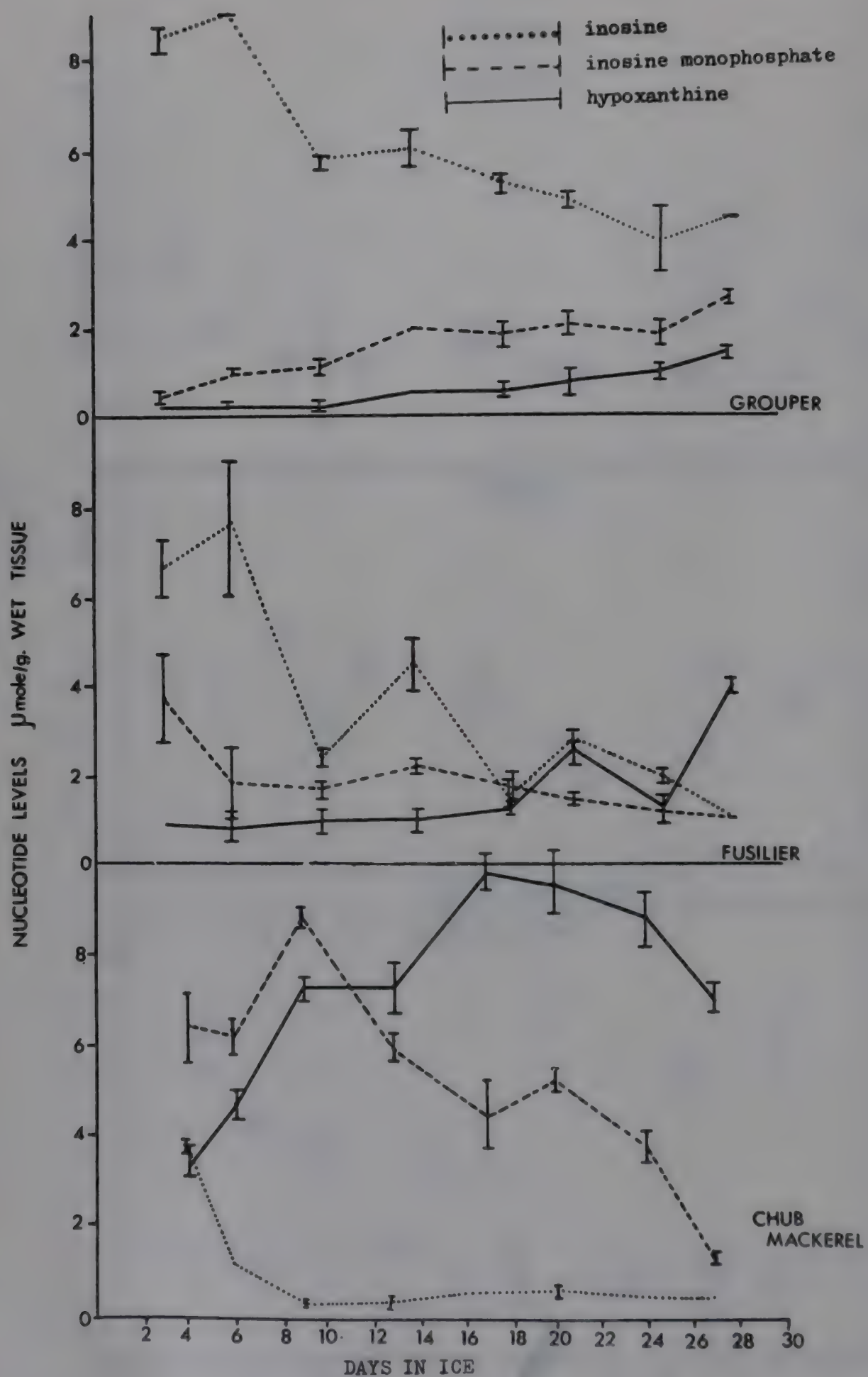


Fig. 6 — The effect of storage in ice on nucleotide levels.

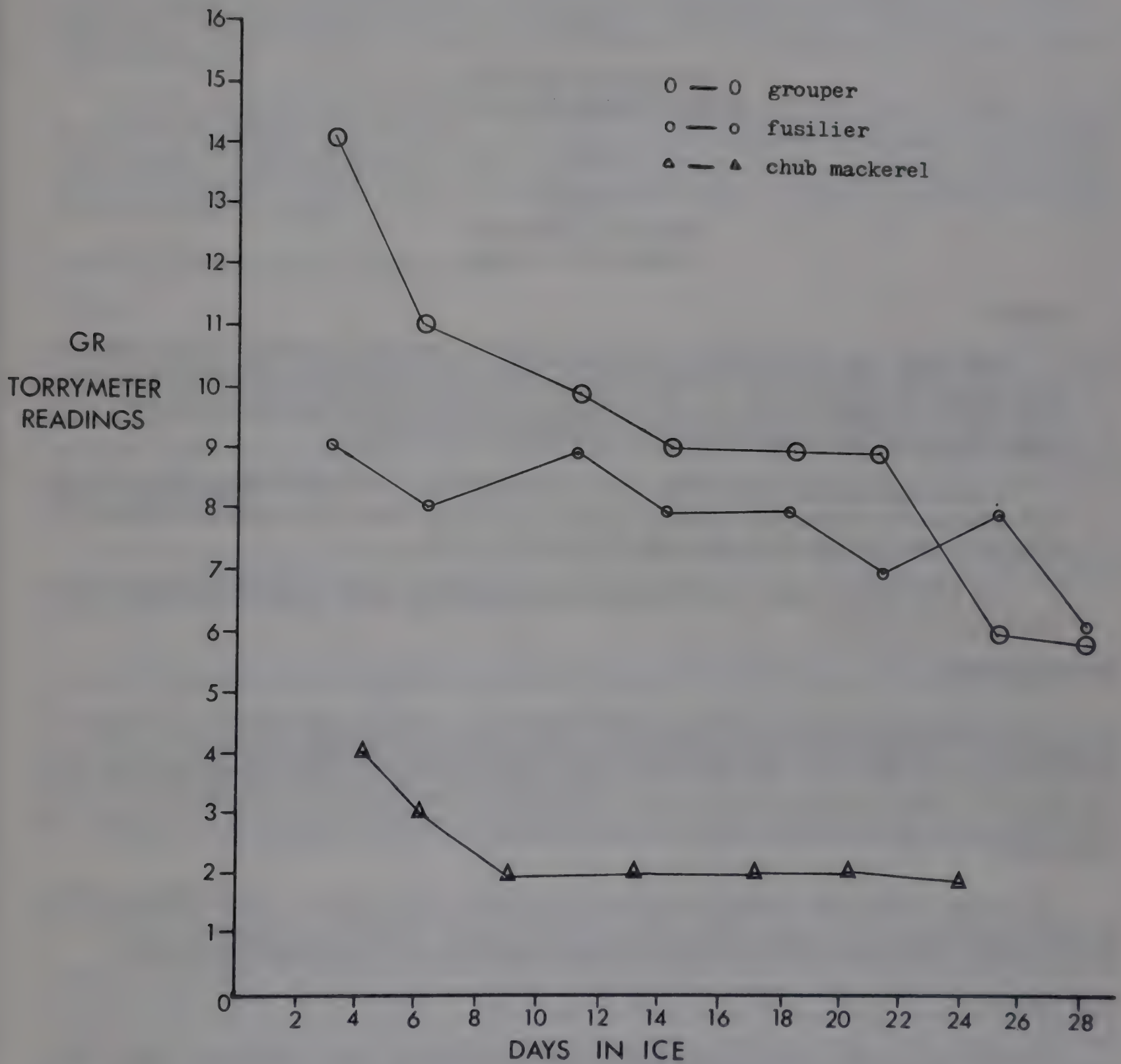


Fig. 7 — The effect of storage in ice on GR Torrymeter readings.

A REFRIGERATED SEA WATER PLANT FOR SMALL BOATS

by

N.S. Boyd and N.D. Wilson
Massey University, New Zealand

and

A. Edley
Engineered Cold Systems
Auckland, New Zealand

Abstract

Many small boats of less than 12 m have inadequate or no method of chilling the catch. The time spent at sea is therefore limited to one or two days. It has been shown that the quality of fish landed from a day boat is of marginal quality. Because the supply of ice for small boat operators is inadequate, it was thought desirable to have a fully self-contained chilling system on each boat.

A small refrigerated sea water (RSW) plant is proposed based on a Canadian-designed shell and tube heat exchanger. The chilling plant assembly requires a 4 kW power source and is capable of chilling 1,000 kg of fish per day. The size of the plant could be increased if desired.

The RSW could be used to chill the fish in several ways: in a tank, by plumbing together several plastic drums, or by sprays.

INTRODUCTION

In New Zealand there are approximately 2,000 fishing boats, of which at least 50 percent are under 12 m in length. Many of these smaller boats are away from port for one or two days and generally do not have any means of chilling the catch. They often fish from minor ports which have no ice. Those fishing from larger ports may also find it difficult to obtain easy access to ice. To try to overcome this problem, some boats have installed large air blowers in the fish hold to chill the catch. This method of chilling is not as good as icing (Boyd and Wilson, 1975).

The owners of these small fishing boats are being encouraged both by changes in market requirements and by regulations (MAF, 1977) to employ some means of chilling the catch adequately. It is suggested that where ice is not available, a small refrigerated sea water (RSW) system might serve the needs of small boat operators.

RSW SPRAYS

Over the last few years some of the larger trawlers have experimented with an RSW spray system (Edley, 1976; Lawson, 1977). This involves adding 250 to 1 000 l of sea water to the fish hold, circulating this water through an external heat exchanger and spraying it back over the top of the fish.

The heat exchanger is of the shell and tube type and contains galvanized mild steel tubes to give a total heat exchange surface area of 6.2 m. The efficiency of these heat exchangers is considerably reduced when the temperature of the circulating sea water falls below 5°C. Hot gas by-pass valves are used to control the compressor capacity and to prevent freezing-up of the heat exchanger and, since these valves invariably begin to open before the sea water temperature reaches 0°C, a further loss of efficiency results.

On a trawler, once the first few trawls of fish have been chilled down to 0°C in the fish hold, subsequent additions of fish to the hold result in a rise in the circulating sea water temperature of less than 5°C. Therefore a heat exchanger that will still work efficiently when the water temperature approaches 0°C is required. A Canadian-designed heat exchanger described by Roach *et al.* (1961) appears to be the most suitable for this application. It is of the shell and tube type containing copper tubes, and a scaled-down version was used in the work described here.

Attempts have been made to chill trawl fish using the standard RSW methods where the fish are immersed in large tanks of chilled sea water. This has proved unsatisfactory for some important species of trawl fish, particularly snapper (*Chrysophrys auratus*), because of excessive descaling caused by movement. This descaling is particularly important with fish destined for the Japanese market which considers the appearance of the fish an important criterion of quality.

LABORATORY TRIALS WITH RSW SPRAYS

Method

The equipment shown in Figure 1 was used to determine the spoilage pattern of snapper, blue mackerel (*Scomber australasicus*) and flatfish (*Rhombosolea plebia*) during storage under RSW sprays. The refrigeration equipment was able to control the temperature of the water at -1 (-0.3)°C which was sprayed over the fish at the rate of 1 000 l/h per m². The water used was a brine solution controlled to between 2.5 and 3 percent by addition of salt when required. In the case of blue mackerel the same water was left in the tank for the duration of the test. With snapper and flatfish it was changed every 48 hours to determine whether bacterial counts in the water can be reduced.

On very second day five of each species of fish were removed from the tank and rinsed to remove excess salt from the skin. One fillet from each snapper and flatfish was tasted and scored for freshness (flavour) on a ten-point scale (Boyd and Wilson, 1976), Blue mackerel was not tasted.

From the other five fillets, 1-g samples of flesh were removed from the anterior dorsal region and pooled by species for hypoxanthine (Hx) determination using the automated enzymatic method of Burt *et al.* (1968).

The remainder of the fillets were minced together by species, and used to determine two thiobarbituric acid values, by the methods of Maclean and Castell (1964), the results being recorded for the first method as absorbance at 538 nm and for the second as salt (by titration).

Viable aerobic bacterial counts of the circulating water were made on nutrient agar incubated at 25°C.

Results and discussion

Changes in taste panel scores for snapper and flatfish during storage under RSW sprays were found to be similar to those that are encountered with iced fish (Table 1). What was not recorded by these scores was the additional slight bilgy off-odours and flavours after about eight days storage. These off-odours and flavours are associated with a rapid rise in bacterial numbers in the circulating water. The numbers were about two log scales higher than those reported for RSW storage of ling cod and salmon (Tomlinson *et al.*, 1974). Changing the water every second day did little to prevent the rapid rise in bacterial numbers after six days storage. Similar increases have occurred under commercial conditions especially when the cleaning of the fish hold has not been adequate between fishing trips.

The storage life using RSW sprays may also be limited by increases in salt content in the fish flesh. The maximum desirable salt content is about 0.5 percent (Tomlinson *et al.*, 1974). Flatfish had reached this level within four days and mackerel after seven days but snapper remained below 0.5 percent salt even after 13 days storage. The increases in Hx content were considerably slower under an RSW spray than that which occurs in iced fish.

SUGGESTED DESIGN FOR A SMALL RSW PLANT

A schematic layout for an RSW plant suitable for small boat application is shown in Figure 2. The heat exchanger is a 1.25 m length of 10 cm PVC pipe containing 12 m of 15.9 mm copper tubing in a single pass as the evaporator. This gives a heat transfer surface area of 0.6 m². It is suggested that a small automotive-type open-drive reciprocating compressor, fitted with a magnetic clutch is used. A self-priming sea water circulating pump, delivering 4 000 l/h is also required. To provide an economic and compact arrangement the compressor and pump could be belt-driven by a 4-kW motor.

The rate of heat flow across the heat exchanger is given in Figure 3 and is expressed in kW/m². The drop in heat flow rate as the sea water was chilled from 9°C to 0°C was 28 percent. In the heat exchanger containing mild steel tubes the drop in heat flow rate over the same temperature range was 80 percent.

Table 1
Quality changes during storage under RSW sprays

Species	Chill storage period (days)	Flavour	Hypoxanthine (μ M/g)		Salt (%)	TBA (Absorbance at 538 nm)	Numbers of bacteria $\times 10^{-6}$
Snapper	2	9.0 (9.4) ^{a/}	0	(.04) ^{a/}	0.09	0.083	0.043
	4	8.5 (8.6)	0	(.20)	0.17	0.037	0.330
	6	8.0 (7.8)	0.02	(.37)	0.16	0.015	0.480
	8	7.5 (7.0)	0.06	(.54)	0.21	0.008	1.780
	10	7.0 (6.0)	0.06	(.70)	0.34	0.011	14.300
	13	6.0 (5.0)	0.31	(.95)	0.32	0.022	27.000
Flatfish	2	9.0 (9.5)	0.14	(.39)	0.43	0.034	0.077
	4	8.5 (8.3)	0.29	(.62)	0.60	0.128	0.120
	6	8.0 (7.1)	0.39	(.80)	1.04	0.102	0.800
	8	7.0 (6.0)	0.75	(.94)	1.33	0.098	1.100
Blue Mackerel	1	—	0.04		0.13	0.035	0.031
	2	—	0.03		0.14	0.050	0.059
	4	—	0.08		0.35	0.070	0.068
	6	—	0.10		0.48	0.142	0.340
	8	—	0.31		0.51	0.113	37.000
	12	—	0.55		0.73	0.130	40.000

a/ Grade normally encountered when fish is held in ice (Boyd and Wilson, 1977)

Table 2

Approximate costs of small RSW equipment

	N.Z. \$ ^{a/}
Compressor and electric clutch	130
Condenser-receiver	60
Suction trap	30
TEX valve	20
Drier, sight glass, fittings, etc.	50
Heat exchanger	100
Controls	50
Pump	50
Mounting and installation	150
	640

a/ N.Z.\$ 1.00 = U.S.\$ 1.02 (April 1978)

There is a marked drop in suction pressure as the water begins to freeze onto the tubes; this can be used as a means of capacity control by installing a pressure switch on the suction line to turn off the compressor. A pressure switch on the sea water line between the pump and the heat exchanger should also be employed to turn off the compressor if the back pressure becomes too high. This method of capacity control, where a small amount of ice formation on the coils is used to activate a pressure switch, greatly simplifies control without affecting capacity.

If the boat has been constructed with a watertight fish hold the above refrigeration plant can be used to spray RSW over the fish. If there is no fish hold present, suitable containers would have to be found. These containers could be specially constructed from marine plywood or similar materials to fit the available free space in the boat. Alternatively suitable second-hand containers such as 150-l plastic drums could be plumbed together with flexible plastic tubing to obtain sufficient storage capacity.

In Table 2 the approximate costs are given for a small RSW plant capable of chilling up to 1,000 kg of fish per day.

CONCLUSIONS

Small RSW plants suitable for small boat application are possible. By utilizing copper tubes in the heat exchanger and the suggested on/off control system to prevent excessive icing-up, the plant can be made to operate efficiently when the chilled sea water temperatures approach 0°C.

In some existing boats it may be cheaper and simpler to install RSW sprays rather than a tank system.

The storage life of fish under sprays is species-dependent but all cases appear to be limited by a large increase in bacterial numbers in the chilled sea water after the fifth or sixth day.

ACKNOWLEDGEMENTS

We are indebted to Mr. B.J. Anderson, Skipper of the F.V. PIRIMAI for his valued discussions on the practical operation of RSW equipment. The work described was carried out as part of the research programme sponsored by the Fishing Industry Board.

REFERENCES

- Boyd, N.S. and N.D.C. Wilson, A comparison of chilling methods on New Zealand fishing boats. *Food Technol.* 1975 *N.Z.*, 10(7):48-51
- _____, A sensory method for evaluating the quality of snapper (*Chrysophrys auratus*). *N.Z.J. Sci.*, 19, 209-12
1976
- Burt, J.R., J. Murray and G.D. Stroud, An improved automated analysis of Hypoxanthine. *J. Food Technol.* 1968 *3*:165
- Edley, J.R., The brine spray method of refrigerating fish at sea. Paper delivered to I.L.R. Comm. C2, D1, D2, D3, and E.1, Melbourne
1977
- MacLean, J. and C.H. Castell, Rancidity in lean fish muscle. 1. A proposed accelerated copper-catalyzed method for evaluating the tendency of fish muscle to become rancid. *J. Fish-Res. Board Can.*, 21(6) 1346-59
1965
- New Zealand, Ministry of Fisheries, Fish (packing for export) regulations. Wellington, New Zealand, Government Printer
1977
- Roach, S.W., J.S.M. Harrison and H.L.A. Tarr, Storage and transport of fish in refrigerated sea water. *Bull. Fish. Res. Board Can.*, (126):61 p.
1961
- Tomlinson, N. *et al.*, Comparison between refrigerated sea water (with or without added carbon dioxide) and ice as storage media for fish to be subsequently frozen. Proc. I.L.R. Comm. B-2, D-3, Tokyo
1974

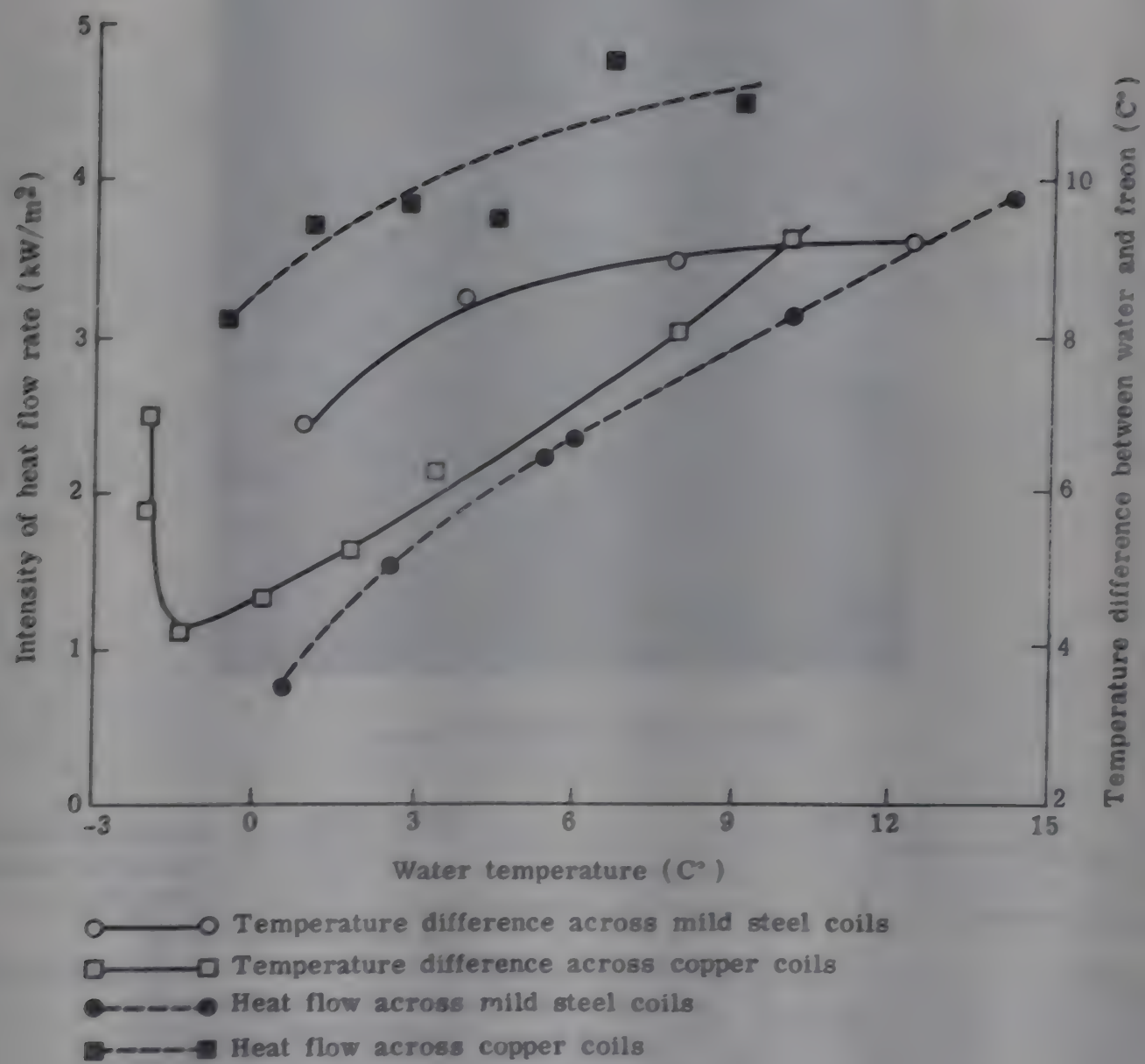


Figure 3 – Performance curves for copper and mild steel heat exchangers



Figure 1 - Pilot model RSW plant.

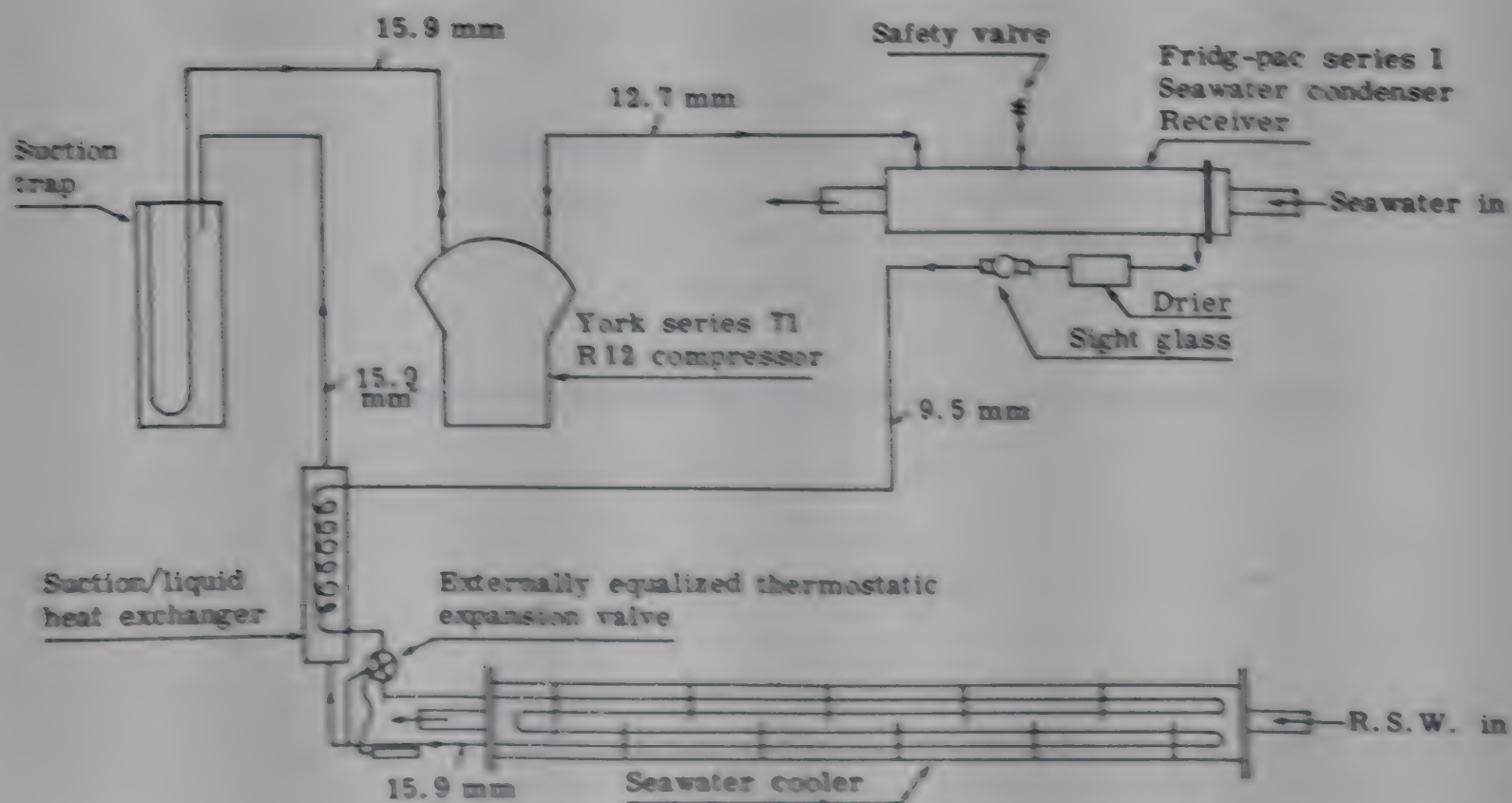


Figure 2 - Schematic layout of RSW refrigeration system

HANDLING AND CHILLING METHODS AND THEIR EFFECT ON QUALITY

by

M.S. Boyd and H.D.C. Wilson
Massey University

New Zealand

Abstract

A large number of boats in the New Zealand fishing fleet are between 9 and 22 m length. They are seldom at sea for longer than 7 days and many of the smaller boats land their catch daily. Most of the boats that are at sea for 1-2 days do not chill the catch, while others fishing from ports without ice plants use air chillers to preserve the catch.

This paper reviews the handling and chilling methods used in New Zealand. The methods are evaluated in terms of the chilling rates achieved, the ability of the method to maintain chill conditions and the quality of the fish landed.

The effects on quality of handling delays on deck and of overchilling the catch are also examined. It was found that for every hour fish are held on deck at temperatures between 14°C and 18°C they lose the equivalent of 1 day's shelf-life in ice.

INTRODUCTION

Until recently only a few of the major New Zealand ports had adequate facilities for supplying ice to chill fish on fishing boats. Because of the lack of ice, many of the boats use air chillers to circulate air at about -10°C over the catch which is stowed in wooden slatted boxes. In the absence of any chilling method, the fishermen limit their fishing trips to less than 24 h to enable them to land fish of an acceptable quality. Even in those boats using ice, air chillers are generally employed to augment inadequate ice supplies. Although the number of ice plants is increasing there are still many boats using air chillers or are not chilling at all.

A comparison of the rates of chilling of the various methods in use in New Zealand and their relative abilities to maintain stable fish temperatures has been made by Boyd and Wilson (1975). Well-iced fish can be chilled to 0°C in 4-6 h depending on fish size, whereas air-chilled fish can take at least 24 h to reach this temperature.

Catching rates also markedly affect the performance of a chilling system, especially on New Zealand boats which operate with a very small crew. High catching rates often lead to inadequate icing and, consequently, chilling times are 4 to 6 times longer than for correctly iced fish. Alternatively, insufficient ice is used and the fish will not be chilled to 0°C. With mechanical air chillers the quantity of refrigeration available is fixed and high catching rates result in a chilling time of 2 or more days. At low catching rates the temperature of the fish often falls to -2 to -4°C and is thus in a partially frozen state. Partial freezing can also occur in boats which employ air chiller units in the fish hold to supplement their ice supply.

This paper examines the effect of these chilling methods on quality. It also examines the effect that delays in handling the catch on deck have on quality.

METHOD

Fish Samples

The quality of fish landed by trawlers was determined by taking 50-60 fish at regular intervals during the unloading of the boats, packing the fish into ice and holding them for evaluation the next day.

In order to determine the effect of partial freezing, freshly caught snapper were iced in plastic containers and held in the fish hold of a boat fitted with an air chiller for up to 5 days. The air temperature in the hold fluctuated between 3°C and 11°C and the temperature of the fish at the time of unloading was $-3(\pm 1)^{\circ}\text{C}$. The effect on quality of handling delays on deck prior to chilling was determined on flatfish. Groups of 6 fish from one trawl were left on deck for periods up to 4 h, then chilled in ice and held for 2 days before examination.

Quality Evaluations

The quality of the fish was evaluated organoleptically by a taste panel using the score sheet of Boyd and Wilson (1976). In this score sheet the general appearance, gill odour, cooked odour and flavour are graded on a 10-point scale. A score of 10 indicates very fresh fish and 1 denotes almost inedible fish; cooked texture was graded on a scale of 5–0.

The hypoxanthine (Hx) levels in each fish were measured by the automated enzymic method of Burt *et al.* (1968). When delays occurred between sampling and quality determination, the appropriate loss of quality that is normally encountered during iced storage (Boyd and Wilson, 1977) was subtracted from the results.

RESULTS

A trawler seldom catches consistent quantities of fish in each tow and there may be a factor of 3 or more between the quantity of fish caught on different days. Examples of the quality of fish landed from boats which use different methods of chilling are given in Table 1. They were obtained when the catching rate during the fishing trip was relatively constant.

Table 1

The quality of fish at the time of unloading fishing boats

Chilling Method	Duration of voyage	Temperature on landing (°C)	Landed Quality		Loss in Quality from well iced fish	
			General appearance	Hypoxanthine (umole/g)	General appearance	Hypoxanthine (umole/g)
Snapper iced in containers	5 days	0.97 (1.26) ^{a/}	8.77 (0.62) ^{a/}	0.245 (0.14) ^{a/}	0.31 (1.1) ^{b/}	-0.161 (1.9) ^{b/}
Snapper air-chilled in boxes	4 days	-2.44 (1.24)	8.78 (0.77)	0.418 (0.095)	0.65 (1.6)	-0.375 (4.6)
Flatfish held on deck	10 hours	16–19	8.48 (0.67)	0.481 (0.141)	2.2 (4.3)	-0.46 (2.6)

a/ Standard deviation

b/ Equivalent days in ice

The iced snapper were packed into plastic containers with a layer of ice placed on top of the fish only. This chilled the fish to an average temperature of 0.97°C . The average quality of the catch as measured by the general appearance at the time of unloading was 8.77. For well-iced fish, the expected general appearance grade after 2.5 days' storage is 9.08 (Boyd and Wilson, 1976). Thus the loss in quality from that theoretically possible was 0.31, equivalent to 1.1 days in ice. Using Hx concentration as a quality indicator the loss of quality was equivalent to 1.9 days.

The boat that used an air chilling system to chill the catch of snapper was at sea for 4 days. A low catching rate prevailed throughout the voyage and the fish were chilled to an average temperature of -2.44°C . Although the general appearance grade was similar to that of iced fish and indicated a quality loss of 1.6 days of iced storage, Hx levels indicated that in fact 4.6 days had been lost.

The quality of flatfish from a boat that was landing its catch in an unchilled state the same day it was caught, was found to have lost an average of 4.3 days of iced storage as measured by the general appearance and 2.6 days according to the Hx concentration. A proportion of the catch was found to have a quality equivalent to 6 days in ice.

Table 2

Regression equations of general appearance, flavour and hypoxanthine concentration in flatfish versus hours that the fish were left on deck

Quality attribute	Constant	Slope	Correlation coefficient	Ratio spoilage rate on deck spoilage rate in ice
General appearance	10.716	-0.555	-0.97	25.9
Flavour	10.617	-0.586	-0.912	25.94
Hypoxanthine (uM/g)	-0.01	0.416	0.89	5.45

Table 2 shows the regression equations for the spoilage rate of flatfish that had been left on deck for periods up to 4 h before being iced. The figures have been corrected for the two days' iced storage. The temperature of the fish was between 16 and 19°C and the spoilage rate as measured by the general appearance and flavour was almost 26 times faster than that which occurs during iced storage. The Hx level indicated a much slower spoilage rate.

Table 3

The quality of snapper during storage in a partially frozen state

Storage time at -3°C (days)	General appearance	Gill odour	Cooked			Hx (umole g)
			odour	texture	flavour	
1	9.3(9.9) ^{a/}	10(10)	10(9.6)	3.8(4.5)	10(9.9)	0.06(0)
2	8.8(9.4)	9.7(9.8)	8.7(9.2)	2.8(4.3)	8.3(9.4)	0.277(.043)
4	8.3(8.6)	9.7(9.2)	7.2(8.4)	0.8(3.8)	5.2(8.6)	0.404(.208)
5	7.8(8.2)	9.2(8.8)	6.2(8)	0. (3.5)	4.2(8.2)	0.477(.29)

Spoilage ratio:

rate at $3(\pm 1)^{\circ}\text{C}$	1.1	0.5	2.35	2.6	3.63	1.97
rate in ice						

a/ Figures in parantheses are expected grades for well-iced fish

The quality of snapper during storage at $-3(\pm 1)^{\circ}\text{C}$ is given in Table 3 and is compared with the quality normally encountered during iced storage. The general appearance of the partially frozen whole fish changed at about the same rate as iced fish and the gill odour at half the rate. However, the taste panel evaluations of cooked odour, texture and flavour show that the actual spoilage rate was 3.76 times faster than during iced storage. After 5 days' storage, the flavour score was that associated with fish at the minimum level of acceptability and all textural quality had been completely lost. The increase in hypoxanthine concentration was twice as fast as that which occurs in ice.

DISCUSSION

The quality of fish from a boat which lands daily ('dah' boat) is approximately the same as that from a boat using ice that has been at sea for 1 week. It should also be noted that, on landing, the fish from a 'day' boat are still at a high temperature and unless they are quickly chilled will continue to spoil at this very rapid rate. The normal practice is to hold the catch from a 'day' boat overnight in a chill room, without the addition of ice, for processing the next day. It is common to find much of this fish at, or close to, the limit of acceptability during processing.

The rapid rate of spoilage of snapper stored in the partially frozen state indicates that the fish were not held under conditions that are normally classified as 'superchilled' but rather that of frozen fish held at a high temperature (Love, 1969). Power *et al.* (1969) also found a rapid loss of texture and flavour in cod that had been pre-chilled to -3.8°C and stored at temperatures between -3.8 and -3.2°C . However, the rate of quality loss reported here is much greater than that reported in the literature. One reason for this may be the large fluctuations in temperature in the fish holds of boats using air chillers as successive loaders of fish are stowed (Boyd and Wilson, 1975).

Long delays before chilling the catch appear to alter the relationship between Hx and flavour that has been established for iced fish. This relationship is also altered by the phenomenon of partial freezing. It was also difficult to establish the eating quality of unchilled fish by grading, using general appearance or gill odour, unless the fish were held for a further period in ice before testing.

The work described in this paper was carried out as part of the research programme sponsored by the Fishing Industry Board.

ACKNOWLEDGEMENT

We would like to thank Messrs. M.J. Wells, R. Sellers, C. Nunn and B.W. Wells, fishermen of Port Nelson, for their valued assistance.

REFERENCES

- Boyd, N.S. and N.D.C. Wilson, A comparison of chilling methods on New Zealand fishing boats. *Food Technol.* 1975 *N.Z.*, 10(7):48-51
- _____, A sensory method for evaluating the quality of snapper (*Chrysophrys auratus*). *N.Z.J.Sci.*, 19:209-12 1976
- _____, Hypoxanthine concentrations as an indication of freshness of iced snapper *N.Z.J.Sci.*, 20:139-43 1977
- Burt, J.R., J. Murray and G.D. Stroud, An improved automated analysis of hypoxanthine. *J.Food Technol.*, 1968
- Love, R.M., Anomalous behaviour of frozen cod muscle stored near its melting point. *In Freezing and irradiation of fish*, edited by R. Kreuzer. London, Fishing News (Books) Ltd., for FAO, pp. 119-24 1969
- Power, H.E., M.L. Morton and R.E. Sinclair, The chemical and physical characteristics of cod stored at superchill temperatures. *In Freezing and irradiation of fish*, edited by R. Kreuzer. London, Fishing News (Books) Ltd., for FAO, pp. 104-13 1969

ICED STORAGE OF MALAYSIAN FISH

by

A. Kamari and Z. Merican
MARDI, Serdang
Selangor, Malaysia

Abstract

Quality changes during the storage in ice of popular Malaysian fish were monitored over a three-day period. Physical, microbiological and sensory evaluation of the various species kept under different ratios of ice was made. Recommendations on the methods of keeping fish in ice were made for the benefit of the trawling industry.

INTRODUCTION

The majority of the 400,000 tonnes of fish landed annually in Malaysia is marketed fresh. Trawling has contributed to the marked growth of the fishing industry over the last decade but it is sad to note that little technological innovation has been adopted to reduce the high losses in terms of quantity and quality. Of the total trash fish caught by trawlers operating off the coast of Selangor (west coast of Peninsular Malaysia), about 20 percent is commercial grade fish while that caught by trawlers off the coast of Trengganu (east coast of Peninsular Malaysia) amounts to about 40-60 percent (Kamari *et al.*, 1977).

Icing is the only method used to preserve fish during all stages of handling, storage and transportation. Crushed block ice is the common form of ice available to the industry, but it is only available in the newly established landing complexes managed by the Fishery Development Authority. In 1975 it was estimated that the annual ice requirement by the fishing industry exceeded the present supply by over 400,000 tonnes (Kamari, 1975).

The ice available to the industry generally is of poor quality. 'Green' ice is commonly supplied to the fishermen and there have been instances when ice was found to have been made from untreated river or well water. Improper handling of ice results in considerable loss through meltage. In Malaysia, ice is considered expensive at U.S.\$ 22 per tonne. Some fishermen do not appreciate the need to ice their catch properly because visible signs of deterioration are not very significant while the fish are still on board the boat. The poor icing practice could be attributed to the high cost and also to the shortage of ice. Trawlers operating on the west coast usually take 2-3 blocks of ice (100 kg each) for a 3-day trip (Selvadurai and Lai, 1976).

There are few organized landing centres in the country and fish is landed at practically all fishing villages along the coast. The packing and transportation of fish from points of landing to large market centres is fairly well organized and those engaged in the business appear to appreciate the importance of using ice. However, the exorbitant cost of ice forbids its use in sufficient quantities. The ratio of ice to fish depends on the distance of the intended market. A 1:1 ratio is normally used for an 18-h journey and 1:1.5 for a 12-h journey (Kamari, 1977).

Microbial and endogenous enzymic activities are the main causes of quality deterioration in fish. Several reports on changes in levels and types of microflora affecting the quality of several species of temperate and tropical fish and crustaceans are available (Shewan, 1977; Cann, 1977; Cobb *et al.*, 1976). Several chemical criteria have been used to measure biochemical changes occurring during enzymatic breakdown in fish during cold storage, for example hypoxanthine (Herzberg *et al.*, 1977); total volatile nitrogen (TVN) and free amino nitrogen (Cobb *et al.*, 1976) and total viable bases (TVB) using the Conway micro-diffusion method. Cobb *et al.* (1976) were able to correlate the production of TVN and free amino nitrogen to bacterial levels and types in shrimps stored in ice.

The initial microbial load present on fish in their natural environment is governed by their habitat and feeding habits, the geography of the area, the season and the temperature and quality of the waters. During catching and handling, further contamination will occur as a result of contact with man. The quality and wholesomeness of the catch will, therefore, depend on the number and type of organisms present and how they are controlled during handling and transportation. Most temperate species carry more psychrophilic microflora than tropical fish. Thus the shelf-life, as affected by bacterial spoilage, of temperate fish stored in ice will be shorter than that of tropical species (Shewan, 1977).

The fish used in the present study is the relatively common *Pristipomoides typus* (sharp-toothed bass) known locally as ikan kerisi bali or ikan merah. Its pattern of spoilage resembles that of *Rastrelliger* species.

The purpose of the work is to determine the quality changes taking place when fish and ice are packed together in various ratios at the point of landing. The present studies report on the changes in physical characteristics, microbial counts and total volatile bases.

MATERIALS AND METHODS

Fish

The fish (ikan kerisi) were bought at the landing point, weighed and packed in boxes in triplicate (six to seven per box depending on size), with the following ice to fish ratios:

T ₁	ice:fish (2:1)
T ₂	ice:fish (1:1)
T ₃	ice:fish (1:1.5)
T ₄	ice:fish (1:2)

Temperature, Torrymeter readings and visual quality appraisal were made on the fish as they were landed. The samples were taken to a mobile laboratory for microbiological, chemical and other determinations.

Boxes

The boxes were made from timber discards. Each box measured 30 x 23 x 15 cm and was provided with a lid made of the same material.

Visual Quality Score

Visual quality score, based on a 0-3 point scale for each parameter, was made by one trained laboratory worker (see Appendix).

Chemical Analysis

Total volatile bases, measured by the Conway diffusion method were used as a measure of quality. A sample was taken from all the fish in each box at the stipulated time.

Total Viable Bacterial Counts

Samples of flesh (10 g) were taken at random and were blended for 2 min in 90 ml of sterile Ringer's Solution in a sterile Waring blender. Aerobic plate counts were carried out on Total Plate Count agar. Appropriate dilutions of the sample in 1 ml aliquots were pipetted into sterile petri dishes, cool molten agar was poured over them and the contents thoroughly mixed. Duplicate plates were incubated at 35°C for three days. The counts reported were the average of the three samples.

RESULTS AND DISCUSSION

Temperature

The average temperature of the fish when landed was 27°C indicating that the icing on board was insufficient. When ice had been used, the temperature of the fish dropped as shown in Fig. 1. The lowest temperature attained was 20°C, as a drop of 7°C for fish iced at 2:1 and 1:1 (ice to fish) ratio, indicating that the amount of ice used is insufficient if the aim is to keep the fish at the temperature of melting ice. After four hours of storage, only treatment T₁ (2:1) had some unmelted ice. In the other treatments, all the ice had melted and the temperature of the fish had started to rise. It took 15 h after icing for treatment T₂ (1:1), T₃ (1:1.5) and T₄ (1:2) and 19 h for treatment T₁ to rise to 24°C.

Quality Deterioration

At the point of landing the fish were considered to have lost about 40 percent of their freshness (visual score of 16 and Torrymeter reading of 11). Thus, the fish were already in an advanced state of deterioration.

Treatment T₄ showed a poorer storage life compared to the other treatments which showed no significant difference. This result could be attributed to the rapid loss of ice. In the other treatments, ice remained for up to 4-5 h after icing. Fish in treatment T₄ were unfit for human consumption (as determined by visual assessment) about 24 h after icing. As shown in Fig. 2 treatments T₁, T₂ and T₃ took about 30 h to reach the same level of deterioration, Torrymeter reading 6-7. The Torrymeter evaluation is able to detect small differences in quality at the early stages of storage (Fig. 3). However, as storage proceeded, the detectable differences by the Torrymeter were less sensitive compared with the visual method.

Microbiological changes

As Fig. 4 shows, there was no significant difference in bacterial counts between the treatments for the 48 h period. However, all treatments showed a continued increase in bacterial counts from landing up to 48 h. Treatment T₁, containing the highest amount of ice, showed a slower rate of increase within a 24 h period and treatments T₃ and T₄ showed a faster increase in counts within the same period.

The fish in treatment T₄ were unacceptable for human consumption after 24 h compared with 36 h for the other treatments. Two of the samples from treatment T₄, were infested with maggots after 48 h. Sampling errors and presence of spreader organisms from the samples also complicated the interpretation of the results.

Total Volatile Bases

The volatile bases released as fish spoil follow the pattern shown in Fig. 5. The samples from treatment T₁ released the least amount of volatile bases. Even 4 h after icing, the difference between the treatments can be seen. The amount of volatile bases released when the fish were visually unfit for human consumption remained constant irrespective of time. After 30-48 h, the amount of volatile bases released levelled out.

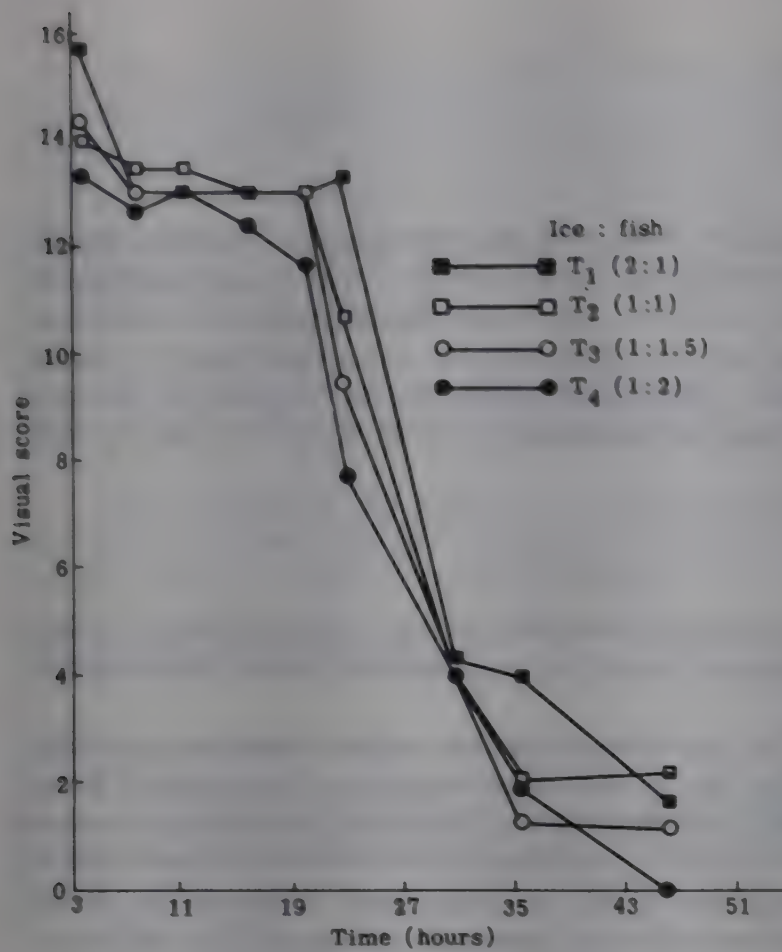


Figure 2 - Average visual score of fish stored in ice

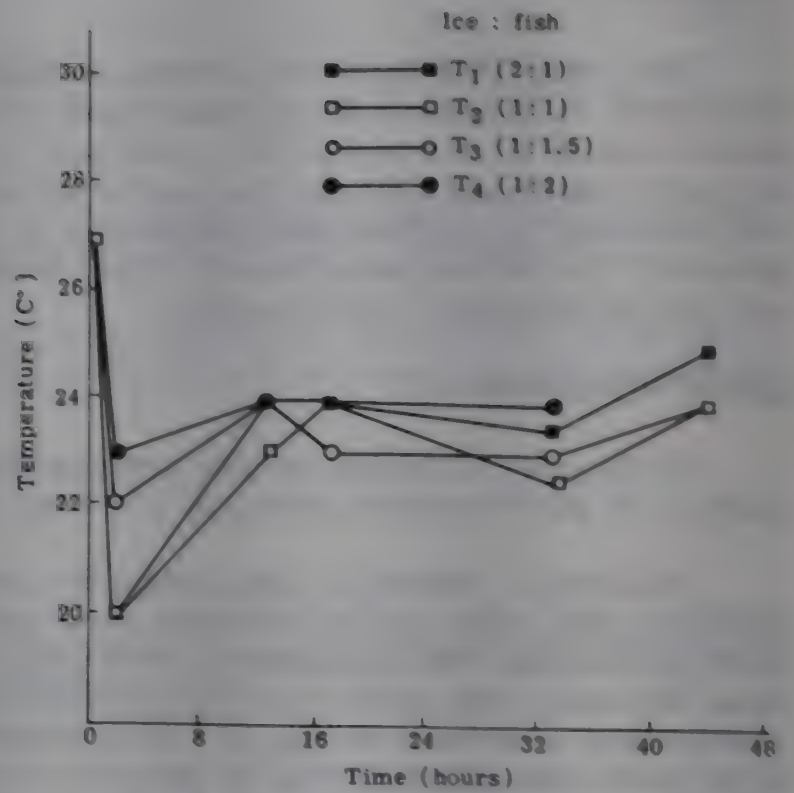


Figure 1 - Temperature of fish stored in ice

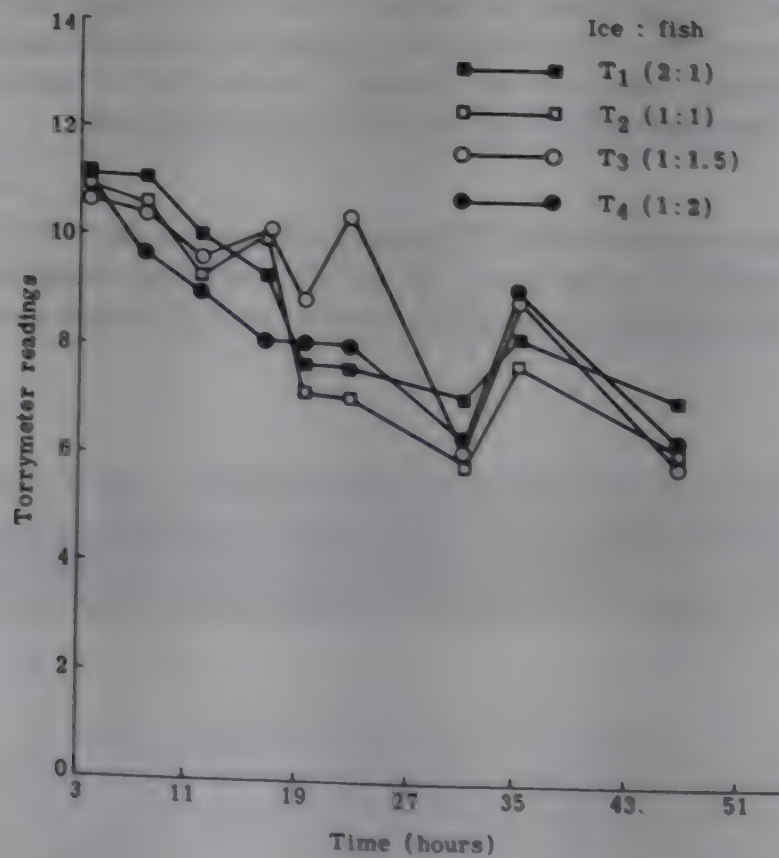


Figure 3 - Average Torrymeter readings of fish stored in ice

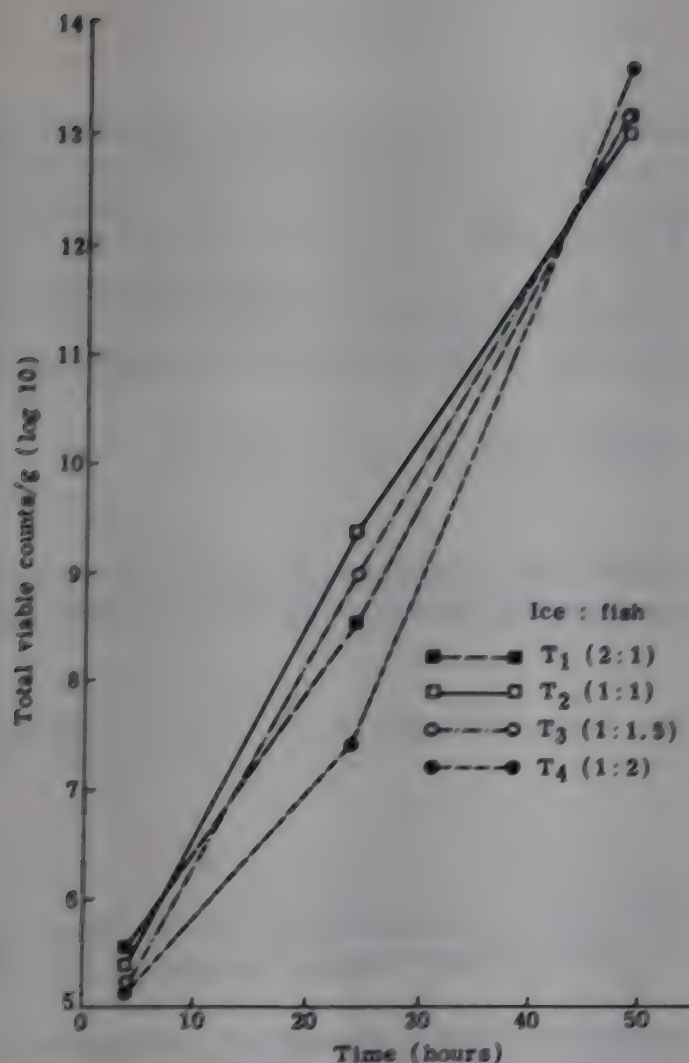


Figure 4 - Total viable counts of fish stored in ice

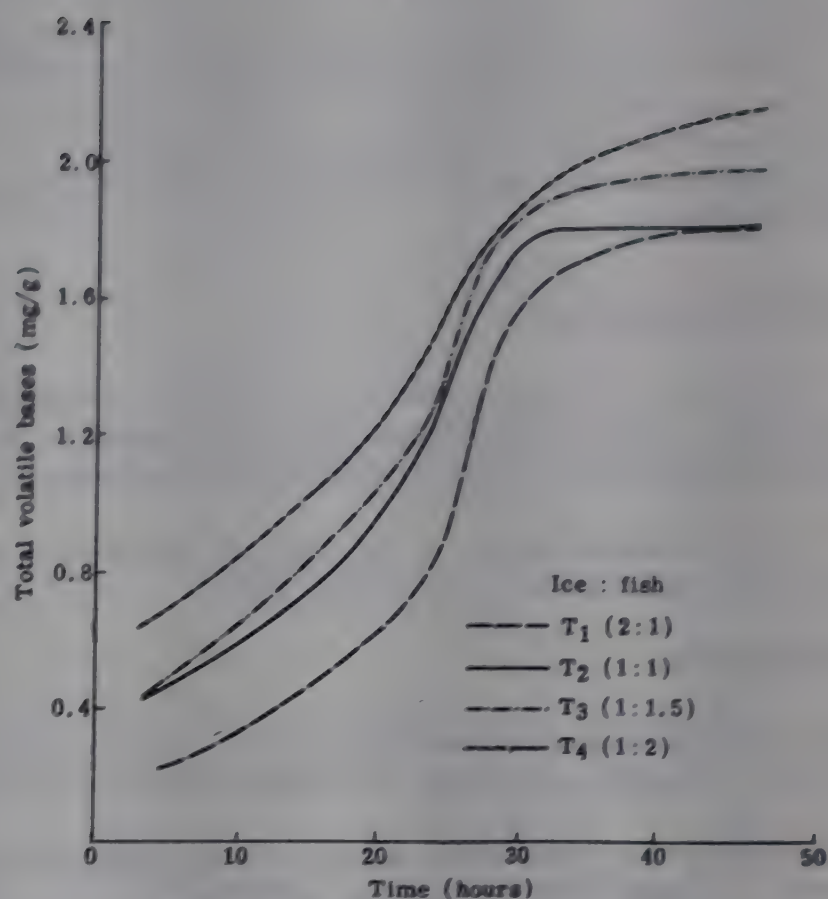


Figure 5 - Total volatile bases of fish stored in ice

RECOMMENDATIONS AND CONCLUSIONS

Ice storage practices on board fishing vessels are very inadequate and must be improved. This is clearly indicated by the temperature (27°C) and the quality of the fish when landed having lost 40 percent of their freshness. The present method of icing fish for transport is just adequate to prevent the fish from deteriorating to a state considered as unfit for human consumption. This practice is true only when there is a constant flow of fish, from catch to consumption. If storage at any point of the handling system is required, a ratio of 2:1 (ice:fish) is inadequate and re-icing is essential. The re-icing must be carried out within 12 h of the initial icing.

With the present system of transportation, ratios of 1:1 or 1:1.5 (ice:fish) are sufficient to prevent marked deterioration in quality. However, it must be stressed that re-icing must be done at the retail and wholesale level in order to prevent further deterioration. Re-icing at the ratio of 1:1.5 (ice:fish) would be sufficient to maintain quality during the time required to sell the fish.

On board the fishing vessel, it is important to ice the fish promptly and to keep the temperature of the fish as low as possible. Under present practices, the amount of ice used is only sufficient to bring down the temperature of the fish to about $26\text{--}27^{\circ}\text{C}$. More work is required to assess the rate of quality deterioration while onboard the fishing vessel.

In order to stabilize daily fish prices, there is a definite need to have facilities that will allow more than one day's storage at the port of landing and at the wholesale centres. The cost of ice needed to prevent deterioration would be high. The cost of storage using the present fish boxes and the amount of ice required may not be economical. There is a need to minimize meltage of the ice, and also to prevent deteriorative changes, by using properly designed fish boxes. Storing iced fish in cold rooms will further reduce meltage. However, the use of cold rooms for such a purpose needs to be evaluated in economic terms.

Cheaper methods of maintaining fish on board fishing vessels must be found. Refrigerated sea water is one possibility. Another alternative is to increase the supply of ice at a much cheaper price. The Government should partly subsidize the cost of ice in order to promote good icing practices especially on the fishing vessels. More ice factories or flake ice machine centres should be established. It is impossible to make the fisherman use more ice under the present situation. Prices of fish, ex-fishing boat, and at the retail level should be dependent on quality as well as upon size and type. This is the only way to encourage good handling practices. There is therefore a need to develop quality standards or grades for the various types of fish in order to implement a price differential system.

ACKNOWLEDGEMENT

This work was made possible by the assistance of several staff whose contributions are greatly appreciated. The authors would like to express their appreciation to Roslima Abdullah, Aishah Aziz, Bahari Ismail, Noor Rehan Abdullah and all others for their technical assistance.

The continued interest of the Head of the Division and the kind permission of the Director General of MARDI to publish this work are highly valued.

REFERENCES

- Cann, D.C., Bacteriology of shellfish with reference to international trade. *In* Proceedings of the Conference on 1977 handling, processing and marketing of tropical fish, London, Tropical Products Institute, pp. 37-94
- Cobb, B.F., *et al.*, Effect of ice storage on microbiological and chemical changes in shrimp and melting ice in a 1977 model system. *J. Food Sci.* 41:29-34
- Herzberg, A., R. Pasteur and M. Rosenblatt, Keeping quality and freshness determination of *Sardinella aurita*. 1977 *In* Proceedings of the conference on handling, processing and marketing of tropical fish, London, Tropical Products Institute, pp.83-8
- Kamari, A., Report to the task force on handling and transportation of fish. Kuala Lumpur, Ministry of Agriculture 1975
- Kamari, A., A.Z. Idrus and Z. Merican, The handling and transportation of fish in Malaysia. *In* Proceedings of 1977 the conference on handling processing and marketing of tropical fish. London, Tropical Products Institute, pp. 115-9
- Selvadurai, S. and K.K. Lai, Marine fish trawling in Peninsular Malaysia. Kuala Lumpur, Ministry of Agriculture 1977
- Shewan, J.M., The bacteriology of fresh and spoiling fish and the biochemical changes induced by bacterial 1977 action. *In* Proceedings of the conference on the handling, processing and marketing of tropical fish, London, Tropical Products Institute, pp. 51-66

APPENDIX

Score Sheet

- 1) PLACE/DATE:
- 2) TIME:
- 3) TYPE OF DEALERS – *Wholesaler, Retailer*
- 4) NAME:
- 5) SOURCE OF FISH (Name of Place):
- 6) TYPE OF FISH:
- 7) SCORE:

	SCORE			
	3	2	1	0
(i) Eyes	Very bright, convex, black pupils	Still bright, convex, slightly grey pupil, opaque cornea	Dull and slightly sunken, grey pupil, milky cornea	Absolutely sunken cornea, pupil totally opaque
(ii) Body	Retain original colour	Slight discoloration	Discoloration of the body	Complete discoloration and faded
(iii) Odour	Seaweed	Shellfish	Flat sour	Putrid, foul or nauseating
(iv) Texture	Firm and hard	Less firm	Some grittiness developed	Very soft
(v) Slime layer	Absent	Absent	Very thin layer present	Thick yellow bacterial slime present
(vi) Scale	Held firm	Held firm	Loose	Come off completely
(vii) Gills	Bright red	Pale red	Brown	Bluish brown
TOTAL:				

FLAVOUR CHANGES DURING THE STORAGE OF MILKFISH
(*CHANOS CHANOS* FORSKAL) IN ICE AND AT -12.2°C

by

C.G. Beza and E.C. Sison

Department of Food Science and Technology, College of Agriculture
University of the Philippines at Los Baños
Laguna 372, Philippines

Abstract

Sensory evaluation, chemical and microbiological tests were carried out on brackishwater and freshwater milkfish during storage in ice and at -12.2°C in order to monitor flavour changes.

The results indicated that freshwater milkfish deteriorated faster than brackish water milkfish characteristic flavour in freshwater milkfish correlated well with IMP levels. However, undesirable flavours were detected at day 12 due to the accumulation of volatile bases and rancidity by-products. The formation of volatile bases and the rise in pH were attributed to bacterial activity and development of rancidity was due to lipolytic activities.

In brackishwater milkfish, flavour scores correlated well with hypoxanthine levels. Undesirable flavours detected at days 21 and low TVN levels were found.

The characteristic flavour of milkfish was maintained during storage at -12.2°C, and after 6 months of storage the fish were still edible.

The predominant microflora found in milkfish were *Alcaligenes*, *Achromobacter*, *Citrobacter*, *Flavobacter*, *Pseudomonas*, *Bacillus*, *Micrococcus* and *Vibrio*. Microbiological counts increased during storage in ice but the counts did not change significantly during storage at -12.2°C.

The chemical and bacteriological changes accompanying flavour development in fish from temperate waters have been the subject of much research (Jones, 1961), but in the case of tropical fish little information is available. Several reports have suggested that fish from tropical waters, whether freshwater or marine, have different flavour characteristics from those of cold-water species. The relationship between autolytic and bacterial changes in temperate fish is also fairly well documented. For tropical fish, information on bacterial changes is limited; on autolytic changes and their control, the information is almost non-existent. The rate of degradation of flavour compounds has not been extensively studied on Pacific Coast species (ACTI, 1974).

This study follows up the changes in flavour components and microbiological counts, of brackishwater and freshwater milkfish (*Chanos chanos* Forskal) commonly known in the Philippines as bangus. As such, it contributes to the knowledge on the microbiology and chemistry of tropical fish.

MATERIALS AND METHODS

Materials

Freshwater milkfish (*Chanos chanos* Forskal), weighing 250 to 300 g and measuring 25 to 30 cm long were obtained from the fishpens of Laguna de Bay in the Los Baños area. Brackishwater fish were obtained from fishponds in the vicinity of Dagupan City, Pangasinan.

Methods

Freshwater and brackishwater milkfish were held in melting ice inside a styrofoam thermo-chest. Fish and ice were placed in alternate layers and the top layer of ice was replenished as necessary. The thermo-chest was placed in a chill-room, maintained at 15.6°C throughout the storage period of 30 days. Further fish were individually wrapped in polyethylene bags and stored in a freezer at -12.2°C . Samples were taken every three days during the iced storage trial and monthly during the frozen storage trial. The samples were subjected to chemical and microbiological analysis and the results were related to changes in flavour.

Sensory evaluation

Taste panel assessment was used to detect flavour changes during the storage period. Fish were descaled, eviscerated, wrapped in aluminium foil and steamed for 15 min. The odour and flavour characteristics of the antero-dorsal portion of the cooked fish were evaluated by 8 semi-trained panelists.

Chemical analysis

For all the tests, except TBA, a sample of muscle was taken from the antero-dorsal portion after removing the skin.

pH — a pH measurement was made on 15 g of muscle macerated in 15 ml of distilled water.

Total volatile nitrogen (TVN) — TVN values were determined by the modified Lucke and Geidel macro-distillation method of Pearson (1970).

2-Thiobarbituric acid value (TBA) — TBA values were measured using the extraction method of CSIRO (1975) which was modified from the distillation and 2-TBA reaction method of Tarladgis *et al.* (1960).

Inosine 5'-monophosphate (IMP) — IMP was determined on a perchloric acid extraction by ion-exchange separation and absorbancy measurements using the method of Spinelli and Kemp (1966).

Hypoxanthine (Hx) — Hx was determined by the xanthine oxidase method as adapted from Jones and Murray (1964).

Microbiological analysis

Microbiological analyses were carried out on samples cut aseptically from the antero-dorsal area of each fish.

Eleven g of muscle were weighed aseptically and homogenized in 99 ml of sterile distilled water in a Waring blender. Appropriate serial dilutions were made and aliquots were plated in duplicate on Tryptone Glucose Yeast Extract Agar (TGYA). The plates were incubated for 48 h at 32°C .

Plates containing 30 to 300 colonies were counted. Twenty colonies were selected at random and isolated into TGYA slants for the determination of morphological and cultural characteristics. Representative isolates were further cultured into specific media for biochemical tests to establish their identity at the generic level. Changes in total bacterial levels were monitored throughout the storage period.

Visual assessment

During the storage period, changes in the general appearance and texture were recorded based upon a scoresheet prepared for snapper (Sumner, 1974, as cited by Olley, 1977).

RESULTS AND DISCUSSION

Sensory evaluation

Changes in odour scores

Odour scores decreased during storage in ice. Strong off-odours were detected at day 15 in the freshwater fish and after 24 days in the brackishwater fish. The fresh fish odour was lost by day 12 in the freshwater fish and by day 21 in the brackishwater fish. During frozen storage no off-odours were detected but, after 6 months, there was a slight loss of the fresh odour.

Changes in flavour scores

Flavour scores decreased during storage in ice (Table 1). The freshwater fish lost their flavour more rapidly than did the brackishwater fish. Taste panelists detected the loss of the fish flavour at day 12 for the freshwater fish and after 21 days for the brackishwater fish.

Table 1

Flavour scores of milkfish during storage in ice

Storage time (days)	Flavour scores	
	Brackishwater fish	Freshwater fish
0	7.2	8.2
3	7.0	7.3
6	7.7	7.5
9	6.9	6.8
12	7.1	4.7
15	5.8	2.6
18	5.1	2.0
21	5.3	2.7
24	4.6	1.5
27	2.2	1.6
30	2.3	1.1

Multiple regression analysis of flavour scores against other factors indicated that hypoxanthine determined the characteristic flavour of brackishwater milkfish whilst IMP influenced the flavour of freshwater fish. TVN and TBA values also affected the flavour scores. The bases formed by bacterial and autolytic action and the by-products of rancidity may have been volatilized during cooking.

Flavour quality loss was detected earlier in the freshwater fish because, although IMP values were still high enough to impart a meaty flavour, the level of the volatile bases and rancidity by-products were sufficiently high to dominate the flavour profile.

In brackishwater fish Hx was the predominant flavour; IMP levels were lower. Initially, the Hx values of brackishwater fish were higher than those of freshwater fish but lower flavour scores were observed in the former. It has been reported that Hx in fish imparts a bitter flavour and it is possible that the panelists detected this since Hx was the dominant flavour component. The relatively low levels of the nitrogenous bases and rancidity by-products had no detectable effect on flavour.

In brackishwater fish, the fall in flavour scores accelerated from the third week due to the accumulation of rancidity by-products and Hx. In freshwater fish, the flavour scores decreased at a faster rate than in the brackishwater fish but the rate slowed probably because of the masking effect of IMP.

Regression analysis of flavour scores with psychrophilic counts indicated that flavour change in freshwater fish was influenced predominantly by the psychrophilic count, while in brackishwater fish, the influence of the psychrophiles was complemented by autolytic changes. Flavour loss was detected when the psychrophilic count was 10^4 /g in freshwater fish, and 10^5 /g in brackishwater fish.

Flavour scores decreased with time during storage at -12.2°C . However, milkfish may be frozen and stored longer than 5 months at constant low temperature. Conditions in this experiment were not constant since intermittent power failures occurred and the quality of the frozen fish was affected by the repeated thawing and freezing.

Regression analyses between flavour scores and chemical parameters for the milkfish stored at -12.2°C showed that the changes were mainly due to autolytic rather than bacterial activity.

Chemical changes

pH

The pH of milkfish during storage in ice and at -12.2°C increased significantly with time of storage. This rise in pH may have been due to the accumulation of basic compounds as a result of proteolytic and putrefactive action.

TVN

As shown in Table 2, the TVN value of freshwater fish during storage in ice increased sharply at day 12 and, after day 21, the values declined. The rapid increase in TVN value coincided with the onset of quality deterioration as detected by sensory evaluation. The de-amination of peptides and amino acids could have caused the rise in TVN value.

Despite the rise in the microbial population during the latter part of storage TVN values fell. Possibly the nitrogenous bases were being metabolized by bacteria faster than they were being produced.

Table 2

TBA values of milkfish during storage in ice

Storage time (days)	TVN (wet basis) (mg/100 g muscle)	
	Brackishwater fish	Freshwater fish
0	25.21	31.10
3	22.03	26.54
6	23.76	30.14
9	18.26	27.32
12	16.00	38.27
15	20.49	39.11
18	20.52	38.14
21	17.70	43.86
24	10.31	12.39
27	13.97	17.16
30	13.54	16.34

TVN values also decreased during storage at -12.2°C .

TBA

The TBA values of brackishwater and freshwater fish in ice rose and fell throughout the storage period but, in general, an upward trend was observed (Table 3). Rancidity was detected at day 15 in freshwater fish and at day 21 in brackishwater fish but the results did not permit any conclusions to be drawn.

Table 3

TBA values of milkfish during storage in ice

Storage time (days)	TBA values (A_{532})	
	Brackishwater fish	Freshwater fish
0	0.055	0.066
3	0.043	0.223
6	0.088	0.103
9	0.073	0.134
12	0.150	0.147
15	0.099	0.240
18	0.094	0.247
21	0.150	0.258
24	0.182	0.155
27	0.183	0.228
30	0.188	0.220

TBA values in milkfish during storage at -12.2°C increased with time, indicating that even in frozen storage, oxidative rancidity occurred.

IMP

IMP was degraded during storage in ice (Table 4). Freshwater milkfish had higher initial IMP levels than brackishwater milkfish but in both types of fish IMP degradation occurred at the same rate.

IMP concentration decreased as the number of psychrophiles increased indicating that they were involved in the degradation of IMP

IMP was similarly degraded during storage at -12.2°C (Table 5). In the freshwater fish IMP declined at a rate of 0.69 $\mu\text{moles/g/day}$ and, in the brackishwater fish, at a rate of 0.52 $\mu\text{moles/g/day}$.

Hypoxanthine

Hypoxanthine increased during storage in ice and at -12.2°C (Table 7). The Hx values of brackishwater fish were higher than those of freshwater fish during storage in ice. The relatively slow increase in Hx concentration of freshwater fish may indicate that the ribose group of inosine was cleaved very slowly (Botta and Shaw, 1976). The formation of Hx correlated with the increase in the number of psychrophiles in freshwater fish.

Even in frozen storage the autolytic enzymes brought about increases in Hx values as storage progressed.

Table 4

IMP values of milkfish during storage in ice

Storage time (days)	IMP content ($\mu\text{mole/g}$)	
	Brackishwater fish	Freshwater fish
0	7.235	8.533
3	5.456	6.850
6	4.952	6.418
9	3.605	5.553
12	3.582	4.399
15	2.740	3.990
18	1.707	3.339
21	1.587	1.755
24	1.034	1.635
27	0.697	1.226
30	0.794	0.866

Table 5

IMP values of milkfish during storage at -12.2°C

Storage time (months)	IMP content (umole/g)	
	Brackishwater fish	Freshwater fish
0	7.345	8.533
1	6.057	7.403
2	6.129	5.048
3	5.649	4.567
4	4.110	4.615
5	4.399	4.495
6	4.158	4.134

Table 6

Hx values of milkfish during storage in ice

Storage time (days)	Hx content (μmole/g)	
	Brackishwater fish	Freshwater fish
0	0.328	0.291
3	0.613	0.491
6	0.716	0.667
9	0.783	0.746
12	0.843	1.109
15	0.867	1.286
18	1.346	1.455
21	1.704	2.043
24	2.249	2.080
27	3.014	2.249
30	3.558	2.807

Table 7

Hx values of milkfish during storage at -12.2°C

Storage time (months)	Hx content (μmole/g)	
	Brackishwater fish	Freshwater fish
0	0.328	0.291
1	0.643	0.395
2	0.443	0.516
3	0.619	0.522
4	1.170	0.649
5	1.425	1.164
6	1.589	1.595

Microbiological changes

Quantitative changes

Microbiological counts in milkfish increased during storage in ice (Table 8). The initial counts in brackish-water and freshwater milkfish were of the same order of magnitude but the predominant flora differed.

Table 8

Total microbiological counts of milkfish during storage in ice

Storage time (days)	Total plate count/g muscle	
	Brackishwater fish	Freshwater fish
0	8.8×10^2	3.8×10^2
3	1.4×10^3	4.0×10^2
6	3.2×10^3	1.4×10^4
9	1.3×10^4	1.3×10^5
12	3.8×10^4	1.7×10^5
15	2.7×10^5	1.1×10^6
18	3.9×10^5	2.2×10^7
21	2.1×10^6	8.2×10^7
24	3.2×10^6	4.7×10^7
27	6.1×10^6	6.3×10^7
30	2.5×10^7	2.8×10^8

During storage in ice the total microbiological counts, as well as psychrophilic counts were higher on freshwater fish than on brackishwater fish causing the former to spoil faster.

The higher counts on freshwater fish may be due to bacteria in the gut content. The freshwater fish were not fasted prior to harvesting whilst the brackishwater fish were fasted for at least a day before harvest and the gut content may have had low microbial counts.

Microbiological counts in milkfish stored at -12.2°C did not change significantly during the 6 months of storage.

Qualitative changes

Qualitatively, the flora did not differ very much between freshwater and brackishwater fish; the difference lay in the relative proportions of the predominant genera. There was a predominance of the gram-negative non-sporeforming rods, mainly *Alcaligenes-Achromobacter*, *Citrobacter* (*Escherichia freundii*), *Vibrio*, *Pseudomonas* and *Flavobacter*, and the gram-positive cocci, *Micrococcus* and *Pediococcus*. *Bacillus* and *Lactobacillus* were found to a certain extent. Mesophilic organisms predominated since milkfish came from relatively warm, tropical water. The bacterial found in the milkfish are similar to those reported by Moorjani (1976) in tropical fish from Indian waters.

Citrobacter predominated over the *Alcaligenes-Achromobacter* group in the brackishwater fish whereas the opposite was observed in freshwater fish. Since the *Alcaligenes-Achromobacter* group produce basic metabolic by-products their predominance may partly explain the higher pH of the freshwater milkfish.

The considerable extension of the shelf-life of milkfish when compared to temperate fish may be due partly to the lower population of psychrophiles in these tropical fish.

Visual appearance

The eyes of the brackishwater fish stored in ice began to lose translucency and started to become cloudy at day 18. Similar changes were observed at day 12 in the freshwater fish. The flesh started to become waxy white at day 21 in the former and at day 12 in the latter. The texture was firm and elastic up to the third day, after which time the flesh became progressively soft and inelastic.

Milkfish stored at -12.2°C were of optimum appearance up to the second month. By the sixth month, the eyes had become cloudy but the gills were still pink. The flesh was slightly translucent, and the scales had loosened.

ACKNOWLEDGEMENT

The authors wish to express their gratitude to the IRR Chemistry Department for allowing the use of the UV spectrophotometer.

REFERENCES

- Advisory Committee on Technology Innovation (ACTI). Food science in developing countries: a selection of 1974 unsolved problems. National Academy of Sciences, Washington D.C., p.62
- Botta, J. and D. Shaw, Chemical and sensory analysis of roundnose grenadier stored in ice. *J. Food Sci.* 41:1285 1976
- CSIRO, Quantitative determination of malonaldehyde in rancid comminuted fish. Hobart, Tasmania, Division of 1975 Food Research. (Unpubl. MS.)
- Jones, N., Fish flavours. In Proceedings of flavour chemistry symposium. Campbell Soup Co., New Jersey, p.61-9 1961
- Jones, N. and J. Murray, Rapid estimations of hypoxanthine concentrations as indices of the freshness of chill- 1964 stored fish. *J. Sci. Food Agric.*, 15(10):763
- Moorjani, M., Some notes on the microbiology of tropical fish in Indian waters. Report of the Second Session of 1976 of the IPFC working party on fish technology and marketing. IPFC, 17th Session, Colombo, Sri Lanka, 27 Oct.-5 Nov. 1976
- Olley, J., Temperature and seafood spoilage. Paper given at the 1977 School of seafood processors. Hobart, 1977 Tasmania, CSIRO
- Pearson, D., The chemical analysis of foods. Chemical Publishing Co. Inc. New York, p.397 1970
- Spinelli, J. and Jemp. Rapid measurements of IMP and total adenosine nucleotide in fish tissue. *J. Agric. Food 1966 Chem.*, 14(2):176
- Sumner, J., Score sheet for snapper. In Proceedings of fish quality seminar, New Zealand (as cited by Olley, 1977) 1974
- Tarladgis, B.B. et al., A distillation method for the quantitative determination of malonaldehyde in rancid foods. 1960 *J. Am. Oil Chem. Soc.*, 1960:37-44

THE PROBLEM OF BURNT TUNA IN THE HAWAIIAN FISHERY

by

Jean I. Cramer^{1/}, Richard S. Shomura and Heeny S.H. Yuan
Southwest Fisheries Center
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96812

Abstract

The poor quality of the flesh of 'burnt tuna' results in an economic loss to the tuna industry. Rejection of burnt tuna by the consumer is based on visual and taste shortcomings. The present report describes the extent of this problem in the Hawaiian tuna fishery and provides some preliminary results of an ongoing study to understand the phenomenon.

INTRODUCTION

Tunas represent the most important economic fishery resource in the Hawaiian Islands. In 1976 the total domestic tuna catch was 5,550 tonnes with an ex-vessel value of U.S.\$ 6.4 million. While skip-jack tuna, *Katsuwonus pelamis*, was the most important species, making up approximately 80 percent of the landings and 60 percent of the value, the importance of the other tuna species, especially yellow-fin tuna, *Thunnus albacares*, and bigeye tuna, *T. obesus*, has increased markedly in recent years. Table 1 provides catch statistics of the tunas for 1962-76. The increase in landings of the combined yellowfin tuna, bigeye tuna, albacore, *T. alalunga*, and kawakawa, *Euthynnus affinis*, catch has been due primarily to the expansion of the handline fishery for tunas and the increase in recreational fishing. Recreational fishing in Hawaii is unique in that the economically valuable species are often sold through commercial outlets. It is still considered recreational fishing since the fishermen do not depend upon fishing as a means of livelihood.

Economically, the handline fishery for tuna shows a large potential for growth if the problem of burnt tuna can be overcome. The present report provides (1) a brief description of the various types of flesh quality problems faced by the tuna industry, (2) a brief description of the handline and troll fisheries in Hawaii, and (3) results of a current study by the Honolulu Laboratory (Southwest Fisheries Center, National Marine Fisheries Service) and the University of Hawaii to determine the causative factors in the burnt tuna and to seek solutions to this costly problem.

FLESH QUALITY PROBLEMS IN TUNA

Burnt tuna is raw tuna which is paler and softer than normal. The colour may vary from slightly pale (borderline burn) to almost white. The area affected varies from 5 to 100 percent of the edible meat of the fish. In cases of partial burn, the area affected is the part of the meat which is closest to the spinal column. The condition occurs most frequently in large tuna (yellowfin and bigeye from 45 to 136 kg caught in shallow water. The fish is edible but is less desirable for consumption in the raw state and therefore commands a lower price.

Burnt tuna appears to be similar to a condition in pork known as Porcine Stress Syndrome (PSS) (Hugh, 1976). Both conditions involve stress, high body temperatures and acidity of muscle and result in pale and soft muscles.

^{1/} Part of a study made under contract with the Southwest Fisheries Center, National Marine Fisheries Service, NOAA, Honolulu, Hawaii.

Table 1

	Tuna catch, state of Hawaii									
Year	Skipjack tuna		Yellowfin tuna		Bigeye tuna		Albacore		Kawakawa	
	Weight (tonnes)	Value (‘000 U.S.\$)	Weight (tonnes)	Value (‘000 U.S.\$)	Weight (tonnes)	Value (‘000 U.S.\$)	Weight (tonnes)	Value (‘000 U.S.\$)	Weight (tonnes)	Value (‘000 U.S.\$)
1976	4 445	3 827	840	1 673	197	825	27	40	41	23
1975	2 293	2 282	781	1 371	157	673	43	83	30	16
1974	3 374	2 676	523	983	187	731	9	15	16	9
1973	4 878	3 203	349	625	185	688	14	28	15	8
1972	4 953	2 949	375	560	229	684	8	12	17	7
1971	6 053	2 753	389	517	214	568	11	11	13	7
1970	3 335	1 497	320	499	216	510	9	11	8	5
1969	2 706	1 245	192	236	322	673	12	12	18	10
1968	4 229	1 540	188	204	256	499	10	8	13	5
1967	3 648	1 263	228	230	294	476	12	9	22	5
1966	4 258	1 404	228	215	346	483	9	6	13	4
1965	7 331	2 014	226	177	351	471	3	2	7	2
1964	4 094	1 222	227	185	380	493	4	3	16	6
1963	3 675	1 090	175	153	430	502	7	5	27	8
1962	4 272	1 174	180	143	554	598	8	4	6	2

Tuna, along with saury, seerfish, butterfly kingfish and mackerel, normally contain large amounts of free histidine in their muscle tissue. Under certain conditions the free histidine may be decarboxylated by some bacteria to produce high levels of histamine (Greiger, 1944); Kimata and Kawai, 1953;

Growth of histamine producing bacteria is optimum at acidic pH (5-6) and moderately high temperatures (20° -30°C) (Kimata and Akamatsu, 1955). One of the best methods of retarding bacterial histamine formation in fish is storage below freezing (Brown and Arnold^{2/}).

Scombroid fish poisoning clinically resembles histamine poisoning intoxication but controversy exists as to whether histamine, ingested orally, is toxic (Halstead, 1967; Granerus, 1968; Douglas, 1970). A number of reports indicate that histamine taken orally by human subjects is not toxic (Granerus, 1968, Douglas, 1970; Hardy and Smith, 1976). Certain diamines (e.g., putrescine) may alter absorption of histamine (Parrot and Nicot, 1965; Irniste, 1973). Alterations in the condition of the intestinal tract from consumption of highly seasoned hot dishes or alcohol may cause increased absorption of histamine (Geiger, 1955). Whether histamine is the sole toxic factor or not, it is generally found at high concentrations in foods causing scombroid poisoning (Simidu and Hibiki, 1955; Ferencik, 1970).

Honeycombing is a condition which is noticed after precooking tuna for canning. It is characterized by irregular holes or pits penetrating to various depths into the tissue; the pits may be small or covering extensive areas. A transverse section of an extensively affected area has an appearance which suggests an empty honeycomb (Hillig, 1956). Fish in this condition are rejected for human consumption.

Otsu (1957) reported that honeycombing in Hawaiian skipjack tuna resulted from delayed refrigeration and was independent of sexual maturity or size of fish. The rate of honeycombing increased with higher seawater temperatures. When allowed to decompose to varying stages, yellowfin tuna and skipjack tuna with honeycombing had much higher histamine levels than those without the condition (Williams, 1954).

Studies presently in progress, however, indicate that honeycombing and histamine production are not interdependent. Fish incubated in the presence of antibiotics exhibit honeycombing but do not have high histamine levels (H. Frank, Department of Food Science, University of Hawaii, Honolulu, Hawaii 96822, pers. commun.)

'Green tuna' occasionally occurs in precooked tuna when the normal pink colour fails to develop. The cooked meat takes on a tannish-green colour and is rejected as unsuitable for canning (Brown *et al.*, 1958). The pink colouration is due to a haemochrome derived from myoglobin (Brown and Tappel, 1957) and the green is mostly haemochrome (Brown *et al.*, 1958; Naughton *et al.*, 1958). The condition does not appear to be related to oxygen starvation during landing (Haughton *et al.*, 1958). Green tuna is most frequently found in yellowfin tuna.

The condition is not recognizable in the raw state and therefore much effort is wasted in processing the fish. Nagaoka *et al.* (1971) have developed a method for prediction of green tuna. They report that the determination of trimethylamine oxide and trimethylamine contents in the raw dorsal muscle of yellowfin tuna predicts green tuna with an accuracy of 96 percent.

DESCRIPTION OF THE FISHERY

The problem of burnt tuna seems to be most serious with tuna caught by trolling, is serious with tuna caught on night handlines, and minor with tuna caught on longlines. The problem was first brought to the attention of the National Marine Fisheries Service by recreational fishermen who troll in the Kona, Hawaii area.

2/ Brown, W.D. and Arnold S.H., 1957. Histamine toxicity from fish products. Unpubl. manuscr. Institute of Marine Resources, Department of Food Science and Technology, University of California, Davis, California.

Recreational fishermen use rods and reels as fishing gear. They troll lures from a wide variety of boats which range in length from 4 to 18 m. The prime target species are the larger game fish, including yellowfin tuna; blue marlin, *Makaira nigricans*; striped marlin, *Tetrapturus audax*; black marlin, *N. indica*; shortbill spearfish, *T. Angustirostris*; sailfish, *Istiophorus platypterus*; mahimahi, *Coryphaena hippurus*; and wahoo, *Acanthocybium solandri*. Trolling speed is a matter of individual preference and generally ranges from 10 to 20 km/h. Surface water temperatures in the Kona area where the burn problem is most serious vary between 24° and 29°C.

Lines of various sizes are used on the reels. The heaviest line used has a breaking strength of 59 kg or less. Fishermen use lighter lines to make fishing more sporting and challenging. Fighting time, the interval between the taking of the lure by the fish and the boating of the fish is highly variable. For yellowfin tuna, fighting time is partly a function of line strength and fish size. In a sample of 44 yellowfin tuna caught on line with a breaking strength of 36 kg or less, fighting time ranged from 4 to 198 min with a mean of 46 min. The fighting time in a sample of 29 yellowfin tuna, caught on line with a breaking strength of 23 kg or less, ranged from 5 to 329 min with a mean of 93 min. Fish in this sample weighed 46.3 to 115.2 kg. Fishing technique, skill of the fisherman, vitality of the fish and the weather conditions are other factors which will possibly affect fighting time.

Burnt tuna is a serious problem in the night handline fishery for tunas. To our knowledge, this highly effective method is used only on the island of Hawaii and in the Philippines (E. Oswald, South China Seas Fisheries Development and Coordinating Programme, Makati, Rizal, Philippines, 1976, pers. commun.). Until 1976 this method of fishing was limited in Hawaii to a small area off Hilo, Hawaii. Night handline fishermen presently fish in areas off the coastline of the entire southern half of the island of Hawaii.

Fishermen time their trips to arrive at the fishing grounds at sunset. The engine is then shut down and a parachute, 7.2 m in diameter is attached to the bow and lowered into the water. Surface lights of 25 W and/or an underwater light of 50 W are turned on.

The stage is finally set for fishing by tossing overboard a few kilogrammes of chum consisting of chopped-up mackerel scad, *Decapterus pinnulatus*. In areas where the squid, *Notodarus hawaiiensis*, is expected to be available, this is used as bait. Otherwise, mackerel scad is used and fishing for tuna commences.

The handline consists of a hook of Japanese design (Tonkichi BKM No. 53^{3/}) at one end and attached to a leader of about a metre of 7-strand stainless steel wire of 227 kg test, a lead weight of 227 to 397 g, and 110 to 130 m of line which is usually polypropylene rope either 0.95 cm or 0.79 cm in diameter. Three handlines are set initially, one at the bow, one at the stern and one amid ships. As soon as the tuna bite, one line is removed. The baited hooks are lowered 20 to 30 m below the surface and held at that depth by securing the handline to the boat with a restraining line. This line has a breaking strength of about 45 kg and usually breaks when a tuna takes the hook. This high breaking strength is used to increase the probability that the tuna will be securely hooked when it strikes.

After the restraining line breaks the fish pulls out the handline at great speed and in a few seconds, the drag of the line slows down the tuna. When the outgoing line is slow enough for the fisherman to hold it, he hauls the fish to the boat. Once alongside, it is shot in the head with either a handgun or bang-stick, hit again on the head with a baseball bat, gaffed and pulled aboard. The catch is stored in ice or a mixture of ice and seawater.

The fishermen leave the fishing ground to arrive at the auction site by 07.00 h. When fishing distant grounds they unload their catches at the nearest landing and the fish are taken to the auction market by truck.

The fishery catches bigeye and yellowfin tuna primarily. Albacore tuna is also commonly caught. The contribution of these species to the handline fishery catch, in weight and value, for the years 1973, 1974 and 1975 is shown in Table 2. The catch increased from 89.1 to 154.6 tonnes while the value of the catch increased at a slightly faster rate, from U.S.\$ 141.1 to U.S.\$ 327.5 thousand.

Although the total tuna catch increased over the 3 years, the catches of the individual species fluctuated tremendously. In 1974 the catch of bigeye tuna was almost twice as much as the other 2 years; in 1975 the yellowfin tuna catch was more than three times the amount of the previous 2 years and the albacore catch increased fiftyfold.

3 Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA

Table 2

Weight and value of tuna catch of night handline fishery

	Weight (tonnes)			Value ('000 U.S. \$)		
	1973	1974	1975	1973	1974	1975
Bigeye tuna	65.4	120.2	63.1	102.6	249.8	149.5
Yellowfin tuna	23.3	22.9	75.5	38.0	38.4	157.0
Albacore	0.4	0.2	16.1	0.5	0.2	21.0
All tunas	89.1	143.2	154.6	141.1	288.2	327.5

Serious economic losses due to burnt tuna are incurred by night handline fishers. Rebates on burnt fish were reported to range from 5 to 75 percent of the original auction price of the fish. The annual loss to night handline fishermen has been estimated at 16 percent of their 1976 catch. Other economic losses include the shipping costs incurred and the poor reputation that the catch engenders due to the inconsistent quality.

POSSIBLE CAUSATIVE FACTOR IN TUNA FLESH QUALITY

Tunas are unique among fish in that they are warm-bodied; body temperatures up to 15°C above ambient water temperature have been reported, e.g., decked bluefin tuna, *Thunnus thynnus* were 5°C to 15°C above ambient water temperature (Carey *et al.*, 1971). Dizon *et al.* (in press) telemetered deep body temperature from free swimming skipjack tuna and found mean body temperatures to be higher than the ambient water temperature. Maintenance of body temperature above ambient water temperature is possible due to the presence of *rete mirabile* (Carey, 1973).

The *rete mirabile* or 'wonderful net' is a tissue, composed of closely intermingled veins and arteries, which permits the free flow of blood for transport of oxygen and other molecules but impedes the flow of heat from the body tissues to the gills. This conservation of body heat allows the tuna some of the advantages of a homeothermic animal. The higher body temperature increases the speed of metabolic reactions thus making possible a higher maximum swimming speed (Carey, 1973). The ability to conserve heat and metabolize rapidly, however, can lead to hyperthermia and rapid accumulation of metabolic by-products.

These relatively high body temperatures and high metabolic rates may be responsible for honeycombing, green tuna and burnt tuna which are meat quality problems unique to this species.

DEVICES TO REDUCE THE INCIDENCE OF BURNT TUNA

Fishermen have tried various methods to prevent the burnt tuna condition from developing. Some insist that bleeding the fish before chilling is effective. Others advocate precooking the fish by leaving it on deck for up to an hour at night or by placing it under burlap and running seawater over it during the day, before placing it in the icebox. None of these, however, is accepted as being the solution to the problem.

In addition, three devices have been made in an attempt to alleviate the problem; one of them has still to be tried in Hawaii. Use of the other two was very limited and, to our knowledge, is now discontinued.

On the assumption that the burnt condition was caused by improper cooling, the Honolulu Laboratory of the National Marine Fisheries Service distributed for trial a device to hasten the transfer of heat from the warmest part of the fish. The device which had the general shape of a comb consisted of five aluminium baking potato nails (11.7 cm long) held together in a row by an aluminium bar 1 x 1 x 14 cm. Three to five of these were inserted on each side into the dark red flesh that runs longitudinally beneath the lateral line in the section of greatest girth.

After one of the night handline fishermen of Hilo tried the device, the others refused to use them for the following reasons: inserting the devices would require too much time; the bars would not be flushed with the body contours and would thus snag and tear the flesh; bacteria would be introduced; and buyers would not buy fish with holes even if the holes are in flesh that is normally discarded. However, a small group of fishermen in the Kona district used the device until it wore out. Use of the device was reported by one fisherman to have decreased the incidence of burnt tuna; this fact has yet to be substantiated.

In November 1975, Mr. Ogawa of Daiichi Suisan Tsukyi, Japan, demonstrated the use of a metal rod to enhance the chilling of tuna in Hawaii. The tail of the fish was cut off and a rod, approximately 3 mm in diameter, was inserted the full length of the vertebral column. Deep incisions were also made immediately behind the pectoral girdle and the gills were slashed to bleed the fish. Fishermen have resisted this method because of the work involved.

In September 1977 Mr. Haruyoshi Taniguchi, a recognized tuna expert from Japan, described a tool he has developed to kill tunas instantly. It consists of a coring cylinder and a stainless steel wire around which a cooper spring is wrapped. The coring cylinder is used to bore a hole into the fish head at the foramen (whitish spot on the mid-dorsal line just above the eye). A length of wire is inserted through the hole and pushed through the spinal column at least 30 cm. This tool reportedly prevents burnt tuna by quickly destroying the nervous system, thus preventing any further stimulation of physiological activity. This method has not been tested in the Hawaiian Islands (Suisan Sekai, 1977).

STUDY OF CAUSATIVE FACTORS OF BURNT TUNA

A preliminary study was conducted in the autumn of 1977 to investigate the environmental and physiological factors which cause burnt tuna and the similarities of burnt tuna to PSS in swine.

Data were collected at the Hilo fish auction and from a number of night handline boats. Chilling methods used were noted whenever this information was volunteered. The major author made nine trips on seven different boats. The size of the chill box and the amount of ice on board were recorded for each trip. When a large tuna was caught a blood sample was taken by cardiac puncture and the fish was labelled by clamping an ear tag on the pelvic fin.

Immediately after catching and prior to auctioning, the superficial and deep muscle temperatures were taken by inserting an 11 cm probe attached to a telethermometer through the skin of the fish along the midline approximately 11 cm behind the pectoral fin. Superficial temperatures were taken at a depth of 0.5 cm and deep temperatures were taken at a depth of 11 cm unless the backbone prevented insertion to that depth. Sex was recorded if the belly was slit and the gonads were exposed at the time of the auction. Observations were made on all large tuna which were cut on the auction block. The head and tail were cut off and then the fish were quartered. If burn was present, it was recorded.

Samples of tuna meat were obtained at the Honolulu fish auction and were subsequently classified as badly burnt, burnt or not burnt (normal). Two g of each sample were placed in 10 ml of distilled water and homogenized. The pH was then determined. Samples of burnt and normal tuna were assayed for lactate and cultured to determine general bacteria levels.

Samples were also obtained from various parts of a small yellowfin tuna which died during a stress experiment at the Kewalo Research Facility. The pH of these samples was determined using the method described above.

Analysis of variance was used to determine significance of temperature differences between chill techniques and between burnt and normal tuna. The volume of the blood samples collected was not adequate for analysis.

Chill methods

A variety of methods is used to chill fish on the night handline fishing boats. The methods vary in the kind and amount of ice used, mixture of the ice with seawater, location and number of cuts for bleeding and the time the fish are on deck between catching and chilling. Cuts for bleeding were usually at the heart, the belly or the tail.

Five methods of handling are described in Table 3. Deep and superficial temperatures of all tuna over 45 kg were taken at the Hilo auction from 20 September to 15 October 1977 (Table 4). The temperatures were analysed and significant differences in superficial temperatures were found between various chilling techniques (Table 5). Significant differences, however, were found only in the deep temperatures for two pairs of methods (A and D, C and D). The amount of ice carried is probably the most important difference between methods. Deep temperatures were also affected by the amount of time the fish were kept in the chill box. Fish caught early in the evening have a considerably cooler deep temperature than fish caught in the morning.

Table 3

Methods of chilling used by handline fishermen in Hilo, Hawaii

Method A	—	crushed ice (not mixed with water) random cuts for bleeding (few, often none) 5 min on deck between catching and chilling
Method B	—	600 lb block ice mixed with seawater at least 2 cuts for bleeding 5 min on deck between catching and chilling
Method C	—	600 lb block ice mixed with seawater at least 2 cuts for bleeding longer than 5 min on deck
Method D	—	300-450 lb of ice mixed with seawater no cuts for bleeding 5 min on deck between catching and chilling
Method E	—	300-600 lb of ice mixed with seawater random cuts for bleeding 45 min journey (without ice) to auction market

Table 4

Fish body temperatures ($^{\circ}\text{C}$) at time of auction

Method	Number of fish	Average superficial temperature	Average deep temperature
A	17	14.9 + 0.59	22.74 + 1.68
B	44	15.26 + 0.61	24.05 + 0.77
C	14	17.20 + 0.90	21.21 + 1.43
D	21	19.50 + 0.77	26.61 + 0.75
E	6	19.80 + 0.51	24.50 + 1.82

Table 5

Comparison of body temperatures by method of chilling
(analysis of variance tests)

	Superficial temperature				Deep body temperature			
	B	C	D	E	B	C	D	E
A	0.49	2.30 ^{a/}	4.60 ^{b/}	4.85 ^{b/}	1.31	1.53	3.87 ^{a/}	1.76
B		1.94	4.24 ^{b/}	4.49 ^{b/}		2.84	2.56	0.45
C			2.30	2.55 ^{b/}			5.40 ^{b/}	3.34
D				0.25				2.11

a/ Significant at the 0.05% level

b/ Significant at the 0.01% level

No significant differences were found between auction temperatures of burnt and normal fish which were quartered at the Hilo auction (Table 6).

Table 6

Body temperature of burnt and normal tuna at time of auction
(20 September to 15 October 1977)

	Burnt	Not burnt
Sample size	11	18
Body temperature (°C)		
Deep	25.45 + 3.03	25.01 + 3.02
Superficial	17.40 + 2.13	18.10 + 4.11
Average fish weight (lb)	184.64 + 35.88	197.94 + 79.40
Sex ratio	6 males : 3 females	16 males : 1 female

Tissue acidity

The stress of catching may result in acceleration of biochemical activity which will lead to an abnormally low tissue pH, premature *rigor mortis*, short duration of *rigor mortis* and early deterioration of tissue (Borgstrom, 1961). Differences in pH of burnt and normal tuna from the Honolulu auction were observed (Table 7). Burnt fish appeared to be consistently more acidic than the normal fish.

Table 7

The pH of tuna sampled at the Honolulu auction

	All auction samples		Tail		Deep	
	Burnt	Good	Burnt	Good	Burnt	Good
Number of fish	17	5	6	1	4	2
Average pH	5.78	6.12	5.8	6.1	5.76	6.2

CONCLUSIONS

Burnt tuna is the result of two factors, i.e., physiological stress and *post mortem* handling, acting independently or in combination. It appears that physiological stress alone may result in a burnt condition. All methods of chilling including immediate rapid chilling on longline boats can result in burnt tuna. The burnt condition has been observed immediately after catching (V. Ohai, Oceanic International Corporation, Honolulu, Hawaii 96817, 1977, pers. commun.).

It is not clear whether *post mortem* handling alone may result in burnt tuna or whether prior physiological stress is necessary. In any case *post mortem* handling seems to influence the severity of the condition. High levels of bacteria were found in cultures from both burnt and normal tissue samples. The level of bacterial activity may be affected by handling.

It would be very desirable to develop an objective classification system for burnt tuna both from a research and an economic point of view. A colour wheel could be made which when compared with the colour of quartered tuna, would indicate the degree of burn. Also it may be possible to detect burnt tuna by use of a tissue pH probe. If good correlations are found between the colour wheel, a visual classification system and pH, a reliable system of grading uncut tuna may be feasible.

Further evidence is necessary to confirm that malignant hyperthermia is involved. It is also possible that an injection of a buffer such as bicarbonate may be used to counteract the effects of stress.

Current efforts in burnt tuna research are concentrated in the following areas: (1) continued investigation of the effects of catching and chilling techniques, (2) investigations into biochemical, histopathological and microbial differences between normal and burnt tuna immediately after catching and after chilling and (3) development of an objective classification system for burn in whole uncut tuna.

REFERENCES

- Borgstrom, G. (Ed.), Fish as food. New York, Academic Press, vol. 1:725 p.
1961
- Brown, W.D. and A.L. Tappel, Identification of the pink pigment of canned tuna. *Food Res.*, 22:214-21
1957
- Brown, W.D., A.L. Tappel and H.S. Olcott, The pigments of off-colour cooked tuna meat. *Food Res.*,
1958 23:262-8
- Carey, F.G., Fishes with warm bodies. *Sci. Am.*, 228:36-44
1973
- Carey, F.G. *et al.*, Warm bodied fish. *Am. Zool.*, 11:135-43
1971
- Dizon, A.E., R.W. Brill and H.S.H. Yuen, Correlations between environment, physiology, and activity and its effects on thermoregulation in skipjack tuna, *Katsuwonus pelamis*. In *Physiological ecology of tunas*, edited by G.D. Sharp and A.E. Dizon. New York, Academic Press (in press)
- Douglas, W.W., Histamine and antihistamines; 5-hydroxytryptamine and antagonists. In *The pharmacological 1970 basis of therapeutics*, edited by L.S. Goodman and A.G. Gilman. New York, MacMillan, pp. 621-62
- Ferencik, M., Formation of histamine during bacterial decarboxylation of histidine in the flesh of some marine 1970 fishes. *J. Hyg. Epidemiol. Microbiol. Immunol.*, 14:52-60
- Geiger, E., On the specificity of bacterium-decarboxylase. *Proc. Soc. Exp. Biol. Med.*, 55:11-3
1944
- _____, Role of histamine in poisoning with spoiled fish. *Science, Wash.*, 121:865-6
1955
- Granerus, G., Effects of oral histamine, histidine, and diet on urinary excretion of histamine, methylhistamine 1968 and 1-methyl-4-imidazoleacetic acid in man. *Scand. J. Clin. Lab. Invest.*, 22:Suppl. 104:49-58
- Halstead, B., Class Osteichthyes: Schrombotoxic fishes. In *Venomous marine animals of the world*. Washington, 1967 D.C., U.S. Government Printing Office, Vol. 2:639-68
- Hardy, R. and J.G.M. Smith, The storage of mackerel (*Scomber scombrus*) . Development of histamine and 1976 rancidity. *J.Sci. Food Agric.*, 27:595-9
- Hillig, F., Note on honeycombing in decomposed tuna. *J. Assoc. Off. Agric. Chem.*, 39:1015-916
1956
- Hugh, W.I., Elimination of Porcine Stress Syndrome seen. *Swine Rep. Coll. Trop. Agric., Univ. Hawaii*, 15(1)
1976
- Hnisteá, C., Significance and detection of histamine in food. In *The microbial safety of food*, edited by B.C. 1973 Hobbs and J.H.B. Christian. London, Academic Press, pp. 327-43
- Kimata, M. and M. Akamatsu, Biochemistry of achromobacter histamineum. 2. *Mem. Res. Inst. Food Sci. Kyoto 1955 Univ.*, 8:4-18

- Kimata, M. and A. Kawai, The freshness of fish and the amount of histamine presented in the meat. 1. *Mem. 1953 Res. Inst. Food Sci. Kyoto Univ.*, 5:25-54
- Nagaoka, C., M. Yamagata and K. Horimoto, A method for predicting 'greening' of tuna before cooking. *In Fish 1971 inspection and quality control*, edited by R. Kreuzer. London, Fishing News (Books) Ltd., pp. 97-9
- Naughton, J.J., H. Zeitlin and M.M. Frodyma, Spectral reflectance studies of the heme-pigments in tuna-fish flesh. 1958 Some characteristics of the pigments and discoloration of tuna meat. *J. Agric. Food Chem.*, 6:933-8
- Otsu, T., Development of 'honeycombing' in Hawaiian skipjack tuna. *Commer. Fish. Rev.*, 19(1):1-8 1957
- Parrot, J. and G. Nicot, Le role de l'histamine dans l'entoxication alimentaire par le poisson. *Bull. Soc. Hyg. 1965 Aliment.*, 53:73-82
- Simidu, W. and S. Hibiki, Studies on putrefaction of aquatic products. 13. Comparison putrefaction of different 1955 kinds of fish (1). *Bull. Jap. Soc. Sci. Fish.*, 20:298-301
- Suisan Sekai, How to effectively kill tunas in order to maintain quality and higher prices. *Suisan Sekai*, 26(9): 1977 52-7 (Engl. transl. by T. Otsu from Japanese of a portion of an article, 1978, 4 p., transl. No. 25; available Southwest Fish. Cent., Nat'l. Mar. Fish. Serv., NOAA, Honolulu, HI 96812)
- Williams, D.W., Report on chemical indices of decomposition in fish (histamine). *J. Assoc. Off. Agric. Chem.*, 1954 37:567-72

A PRELIMINARY STUDY OF THE MICROBIOLOGY OF ICED CHUB MACKEREL IN THAILAND

by

B. Saisithi and K. Tipkong
Fishery Technology Development Division
Department of Fisheries
Bangkok, Thailand

Abstract

The bacterial flora of newly caught chub mackerel and the subsequent changes occurring during storage in ice up to 5, 10 and 15 days are described. Organisms of the genus *Pseudomonas* represent up to 100 percent of the flora in the later stages of spoilage. Coryneforms were usually present and in one case contributed 60 percent of the total flora. Mesophiles were more predominant in fish from the Andaman Sea while *Vibrio/Aeromonas* seemed to predominate in fish from the Gulf of Thailand.

INTRODUCTION

The microbiology of fresh and spoiling marine fish has been studied by many workers, such as Shewan and Liston (1956) and Stewart (1932). Most of these investigations show changes in the microflora of the intestines and the skin of fish from cold water. Although it had been claimed that there was little bacterial invasion of the flesh until spoilage was well advanced (Dyer *et al.*, 1946), there was much evidence to show that the flesh could contain considerable number of bacteria in the relative early stages (Shewan, 1949). The microflora of widely differing species of fish from the same area were almost identical but were different from other areas (Shewan *et al.*, 1960).

The experiments performed at the Fishery Technological Development Division, Thailand, were part of an investigation to determine the keeping quality of fish and the differences of the microflora of fish taken from the Gulf of Thailand and the Andaman Sea.

MATERIALS AND METHODS

Chub mackerel with an average length of 16.5 cm were used in these experiments. The fish were caught with purse seines and stored in ice, immediately after unloading, for 2 days before the O-day sample was taken and analysed. Subsequent samples were taken for analysis at 5-day intervals.

In order to maintain the fish temperature at 1-2°C throughout the period of the experiment, more ice was added on alternate days. From each fishing ground 40-50 fish were obtained. Each sample contained 6 fish which were used for organoleptic testing (OS), total viable count (TVC), total volatile bases (TVB) and microbial populations. For the organoleptic test, the method described by Park and Kim (1965) was used. Total viable counts were made by the standard plate count method. The medium used was plate count agar with 0.5 percent sodium chloride and 0.5 percent yeast extract. Each sample was incubated for 5 days at 25°C. The determination of TVB was carried out by Conway's micro-diffusion method (Beatty and Gibbon, 1937 — modified by the Technological Laboratory of the Danish Ministry of Fisheries).

For the qualitative microflora analysis, 100 colonies were picked from the plates which contained 30-300 colonies using random number tables and screening for identification. Colonies were streaked on nutrient agar plus 3 percent salt to obtain pure cultures. Each colony was identified by the method discussed in the papers of Hendrie *et al.* (1964), Graham and Hodgkiss (1967) and Shewan *et al.* (1960)

RESULTS AND DISCUSSIONS

Fig. 1 shows that the organoleptic scores (OS) for the fish samples from both fishing grounds decrease steadily during storage. Initially the OS for fish from the Gulf of Thailand and the Andaman Sea were similar,

7.8 and 7.3 respectively and, after 15 days storage in ice, the OS decreased to 3.5 and 3.8 respectively. According to Park and Kim (1965), the organoleptic evaluation method was effective in evaluating the freshness of the fish; an organoleptic score of 4 would be judged as poor quality. The chub mackerel used in this experiment can be kept in ice for about 12 days. TVB and TBC determinations show that fish from the Andaman Sea were superior to those from the Gulf of Thailand (Figs. 2 and 3).

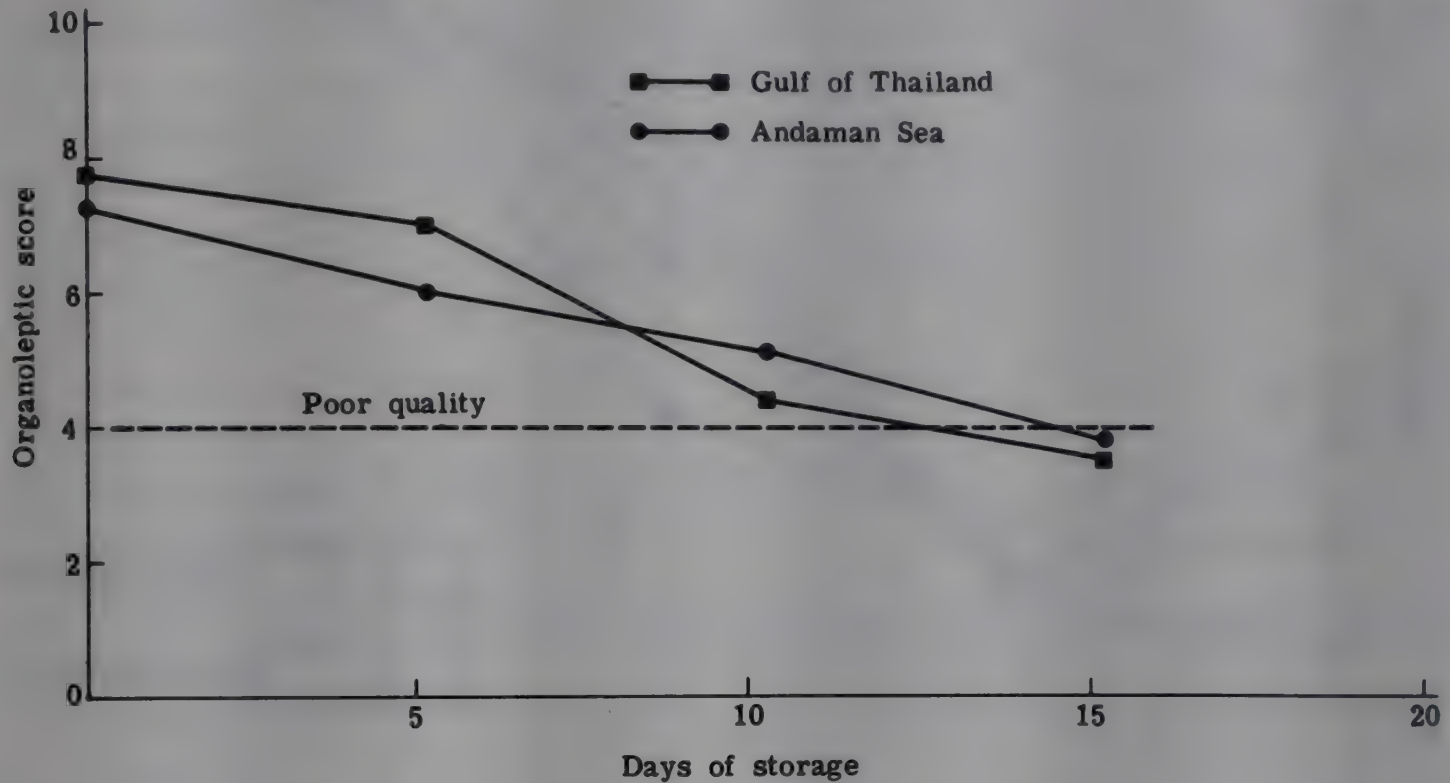


Figure 1 — Organoleptic scores (OS) of chub mackerel during ice storage

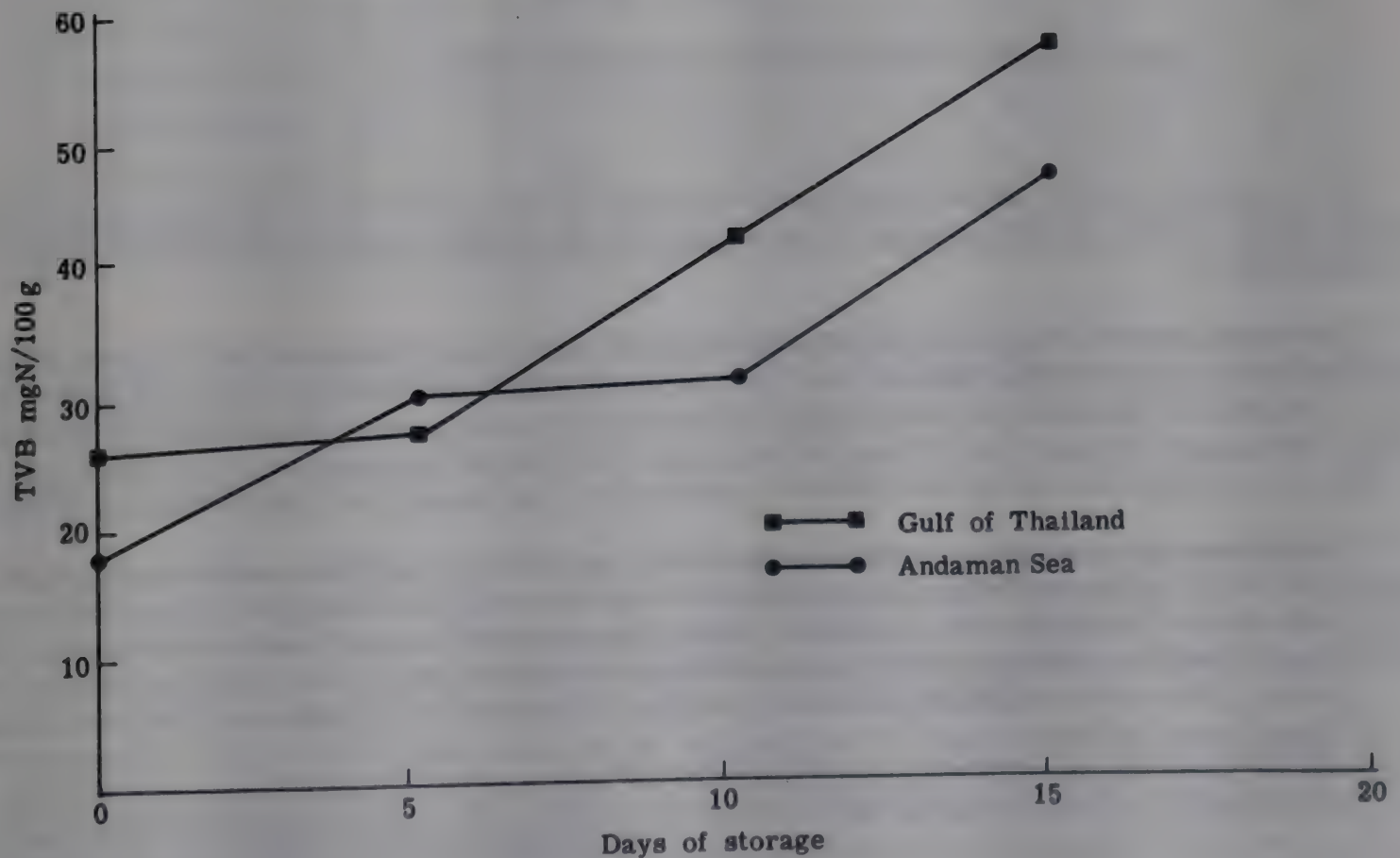


Figure 2 — Total volatile base of chub mackerel during ice storage

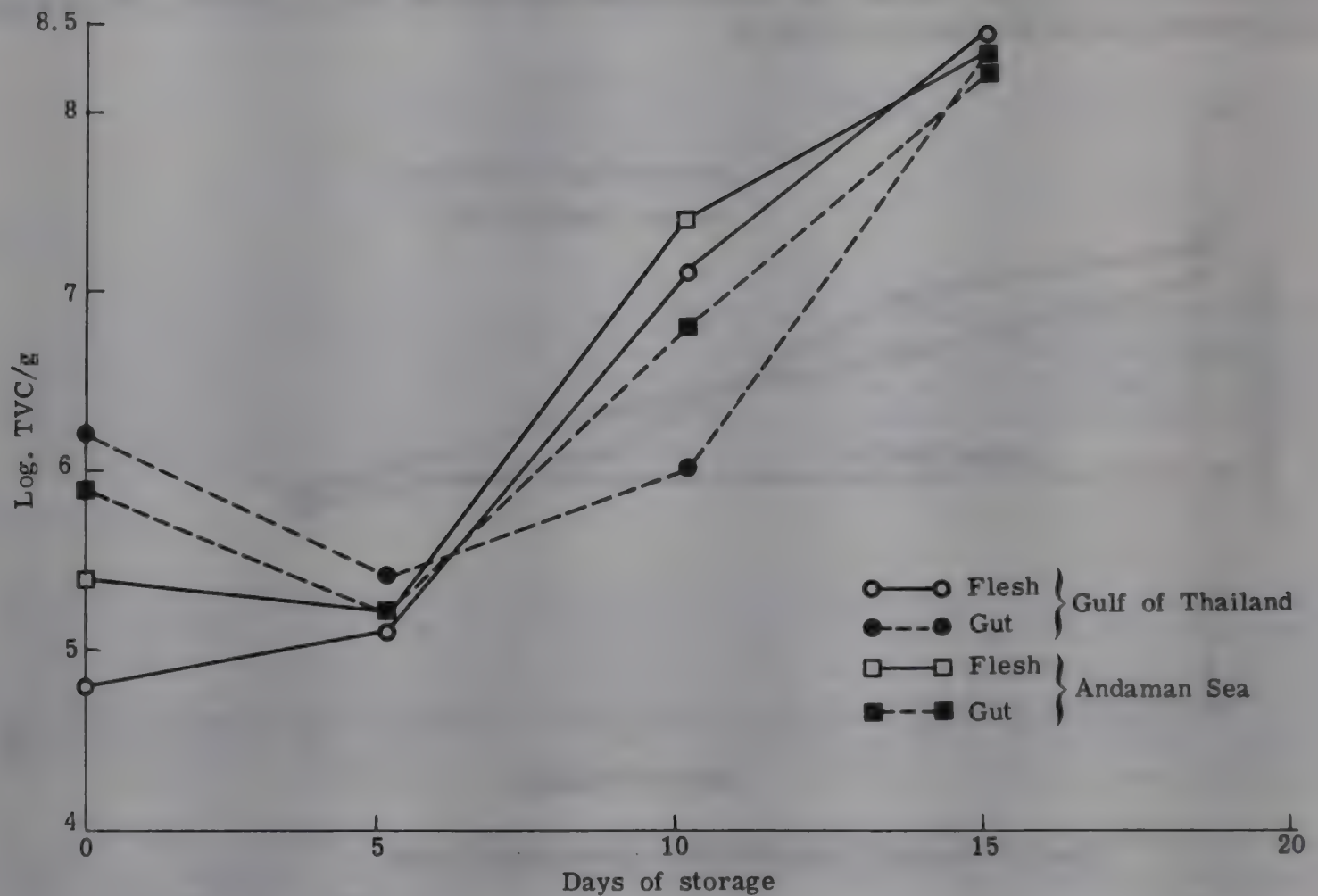


Figure 3 — Total viable count (TVC) of chub mackerel during ice storage

It is interesting to note that the numbers of bacteria in the guts of fish from the Andaman Sea were significantly higher than in the flesh especially when compared to the number found in the fish taken from the Gulf of Thailand (Fig. 3).

Gut microflora of fish from the Andaman Sea decreases more sharply during the first 5 days of ice storage than microflora in the flesh. This indicates that there are more mesophiles in the gut than in the flesh. However, the gut microflora of fish from the Andaman Sea rises slowly whereas the gut microflora of fish from the Gulf of Thailand rises sharply between 5 and 10 days of ice storage. The different behaviour of the gut microflora toward the effect of ice storage is due largely to the lower temperature of the water in the Gulf of Thailand (3°C lower).

Table 1 shows the percentages of different bacterial types in the gut and flesh samples during ice storage. The results clearly indicate that the initial microflora of fish from the two fishing grounds also differ qualitatively. In the flesh of fish taken from the Gulf of Thailand psychrophilic bacteria such as *Pseudomonas*, *Achromobacter* and *Vibrio/Aeromonas* predominate whereas in the fish taken from the Andaman Sea, mesophiles such as coryneforms, *Micrococcus* and *Staphylococcus* predominate. For Table 1, it is also seen that the gut samples have different groups of bacteria from the flesh samples. In the guts of fish from the Gulf of Thailand *Vibrio/Aeromonas* are predominant, while the guts of fish from the Andaman Sea show predominantly Enterobacteriaceae. The presence of Enterobacteriaceae indicates that the Andaman Sea is heavily polluted with faecal matter. Fish from the Gulf of Thailand however could be poisonous due to *Vibrio* food poisoning especially if eaten raw.

Table 1

Microflora of chub mackerel stored in ice (expressed as percentage)

Fishing ground	Genus and/or kind of bacteria	Days of storage							
		0		5		10		15	
		Flesh	Gut	Flesh	Gut	Flesh	Gut	Flesh	Gut
Gulf of Thailand	<i>Pseudomonas</i>	14	8	54	48	96	94	98	100
	<i>Achromobacter</i>	40	8	18	6	—	4	—	—
	<i>Flavobacter/Cytophaga</i>	—	—	10	2	—	—	—	—
	Coryneforms	12	2	6	10	2	2	—	—
	<i>Micrococcus</i>	8	—	—	8	—	—	—	—
	<i>Staphylococcus</i>	4	—	—	2	—	—	—	—
	<i>Vibrio/Aeromonas</i>	22	70	10	10	2	—	2	—
	Enterobacteriaceae	—	10	—	2	—	—	—	—
	Miscellaneous	—	2	2	12	—	—	—	—
Andaman Sea	<i>Pseudomonas</i>	—	—	64	64	68	76	80	88
	<i>Achromobacter</i>	—	26	10	6	12	6	—	—
	<i>Flavobacter/Cytophaga</i>	—	—	—	—	—	—	—	—
	Coryneforms	60	—	10	—	10	—	4	—
	<i>Micrococcus</i>	30	4	—	—	—	—	—	—
	<i>Staphylococcus</i>	10	4	—	2	—	—	—	—
	<i>Vibrio/Aeromonas</i>	—	—	16	14	8	18	16	10
	Enterobacteriaceae	—	60	—	2	2	—	—	2
	Miscellaneous	—	10	—	12	—	—	—	—

Of the spoilage bacteria present in the flesh during ice storage, *Pseudomonas* is the most important genus in both groups of fish. This is followed by *Achromobacter* in fish from the Gulf of Thailand and coryneforms in fish from the Andaman Sea.

CONCLUSION

These results indicate that the microflora of chub mackerel is directly related to its aquatic environment. Fish in warmer water had larger numbers of mesophilic bacteria such as coryneforms, *Micrococcus*, *Staphylococcus* and Enterobacteriaceae than the fish from colder water. Fish caught in the Gulf of Thailand, which is 3°C colder than the Andaman Sea, have more psychrophilic bacteria such as *Pseudomonas*, *Achromobacter* and *Vibrio/Aeromonas*. The spoilage of fish during ice storage is mostly due to *Pseudomonas*.

The presence of Enterobacteriaceae in/on fish caught from the Andaman Sea indicates that the water is polluted, probably with faecal matter. The highest number of *Vibrio/Aeromonas* in fish caught from the Gulf of Thailand indicates the presence of harmful bacteria.

REFERENCES

- Beatty, S.A., and N.E. Gibbons, The measurement of spoilage in fish. *J. Biol. Board Can.*, 3(1) 77 p. 1937
- Dyer, W.J., F.E. Dyer and M. Snow, Amines in fish muscle. 3. Spoilage of iced eviscerated cod. *J. Fish Res. Board Can.*, 3:403
- Graham, D.C. and W. Hodgkiss, Identity of gram negative, yellow pigmented, fermentative bacteria isolated from 1967 plants and animals. *J. Appl. Bacteriol.*, 30(1):175
- Hendrie, M.S., W. Hodgkiss and J.M. Shewan, Considerations on organisms of the *Achromobacter-Alcagenes* 1964 group. *Ann. Inst. Pasteur Lille.*, 15:43 p.
- Park, D.K. and S.B. Kim, A study on the determination of fish quality by sensory assessment. *Proc. IPFC*, 11(3): 1965 343
- Shewan, J.M., Some bacteriological aspects of handling, processing and distribution of fish. *J. R. Sanit. Inst.*, 1949 69:394
- Shewan, J.M. and J. Liston, Objective and subjective assessment of fish quality. *Bull. Inst. Int. Food Annex*, 1956 1:p. 137
- Shewan, J.M., G. Hobbs and W. Hodgkiss, The *Pseudomonas* and *Achromobacter* groups of bacteria in the spoilage 1960 of marine white fish. *J. Appl. Bacteriol.*, 23(3):463
- Stewart, M.M., The bacterial flora of the slime and intestinal contents of the haddock (*Gadus aeglefinus*). *J. Mar. Biol. Assoc. U.K.*, 18:35

USE OF THE TORRYMETER TO ASSESS QUALITY OF MALAYSIAN FISH

by

Z. Merican, A. Kamari and R. Abdullah

MARDI, Serdang
Selangor, Malaysia*Abstract*

The paper gives a background to the various methods of quality evaluation that have been used in Malaysia. These methods are compared with the Torrymeter and some positive correlations were found between organoleptic assessment and Torrymeter readings. The Torrymeter was found to be more sensitive than visual scoring when the fish were relatively fresh and un-iced. The Torrymeter should find a wide use within the fish marketing system in Malaysia.

INTRODUCTION

At present fish in Malaysia are not subject to any quality inspection until they reach the processor or consumer. One of the major problems faced by extension workers is to introduce the concept of quality to the fishermen and the consumer. Efforts to improve and maintain the quality of the catch often fail for a variety of reasons:

The fishermen do not benefit from their extra efforts to maintain good quality and consumers have to pay more for the fish. The fishing industry is also very traditional and any modernization will lead to increased costs.

An improvement in fish quality would result from the liberal use of ice. Once the fishermen accept this idea and benefit financially from the use of ice then it will be easier to introduce other improvements such as fish holds and fish-box design.

The most acceptable quality index to determine freshness for the fishermen and the laymen is the use of visual indices. This, however, is very subjective and an objective method of measuring fish quality is needed. Various quality control indices have been used to measure the freshness of fish but no one method has been found which is applicable to all species. Several chemical procedures are available but they often require destructive sampling and are either slow or impractical for use by the laymen.

A simple and reliable method of quality assessment is required to permit the implementation of differential pricing in the marketing of fish. Differential pricing will promote improved handling practices since better quality fish will fetch better prices and improved handling may prove to be economical. The newly introduced Torrymeter is a rapid and nondestructive means of measuring fish quality. Unfortunately, it responds differently with different species. An investigation into the use of the Torrymeter on commercial Malaysian species is therefore required to determine the potential use for this instrument.

MATERIALS

The fish were bought at landing points, wholesale and retail markets. Some samples were kept in ice while others were left at ambient temperatures. Torrymeter readings and visual assessments of quality were made at intervals until the samples were rated as no longer acceptable for human consumption.

The species used were:

- Kembong (*Rastrelliger kanagurta*)
- Gelama (*Johnius pseudociaerna soldado*)
- Parang (*Chirocentrus dorab*)
- Tongkol (*Kishinoella tonggol*; *Euthynnus alleteratus*)
- Merah (*Pristipomoides typus*)
- Kerisi bali (*Pristipomoides typus*)
- Lidah or sebelah (*Cynoglossus lingua*)
- Sardine or tamban sisek (*Sardinella fimbriata*)

RESULTS

The Torrymeter was able to monitor and detect changes effectively in samples that were fresh. The readings on iced fish seemed to be erratic when compared with un-iced fish. It was found that the Torrymeter readings were not reliable when the fish had deteriorated. The scores for some species were very erratic indicating that the Torrymeter was not responding as expected (Figures 1-4).

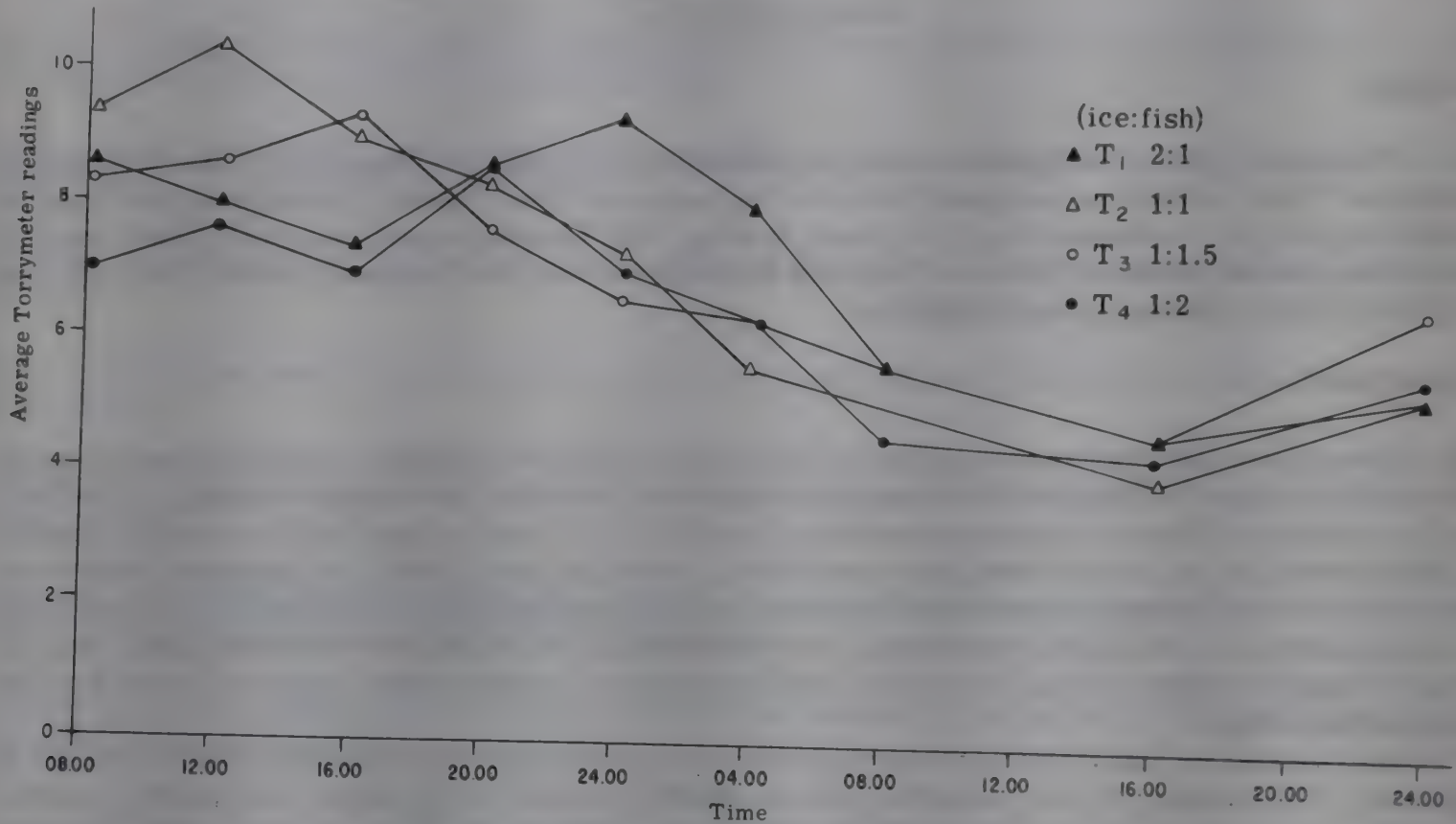


Fig. 1A — Torrymeter readings of iced ikan merah

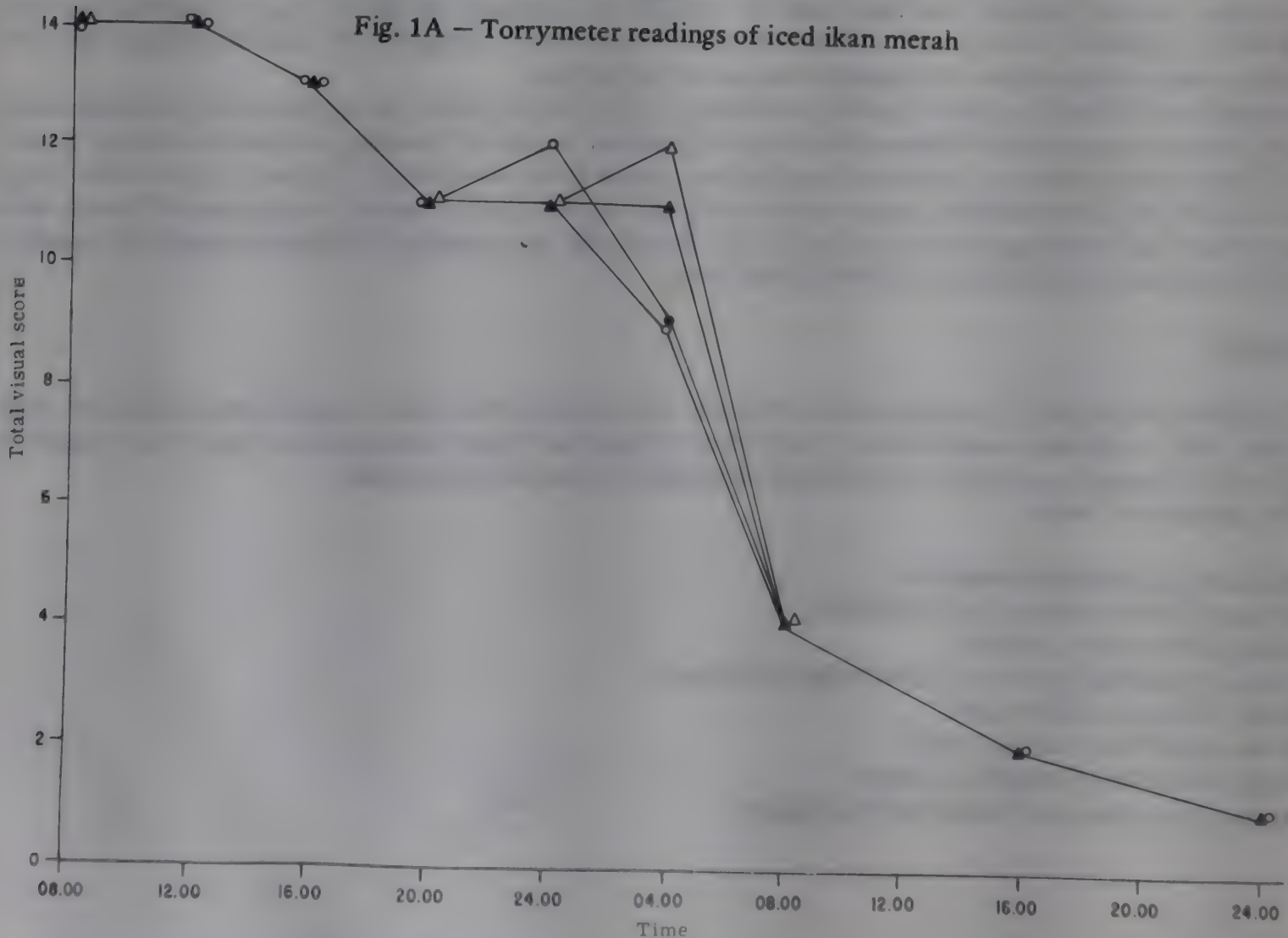


Fig. 1B — Visual score of iced ikan merah

For un-iced samples, six species were monitored and of the six only one (ikan tongkol) showed erratic response. It was noted that different species gave different scores for the same degree of freshness. This can be seen from the range in scores made by visual (12-15) as compared to the Torrymeter (5-13) when the fish were first purchased (Figure 5).

CONCLUSION

Although different fish respond differently to the Torrymeter, a pattern can be formed for the majority of species. The most important criterion in this case is that it is a quick reference method to establish freshness for the layman, fisherman, fishmonger and research worker. More surveys would have to be carried out to establish norms for each variety of Malaysian fish.

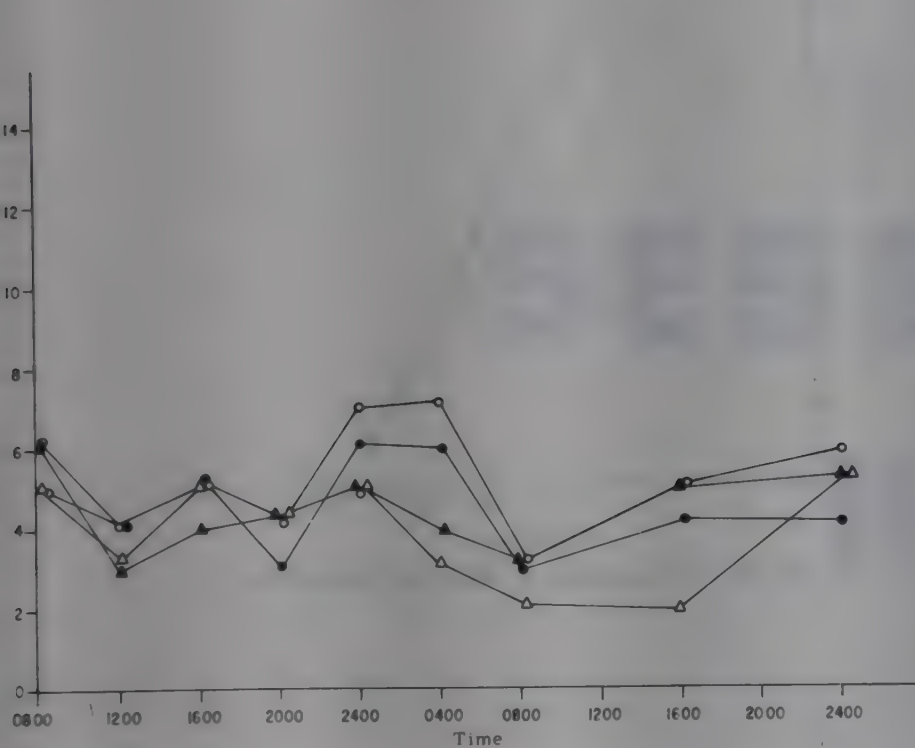


Fig. 2A - Torrymeter readings of iced ikan tuna

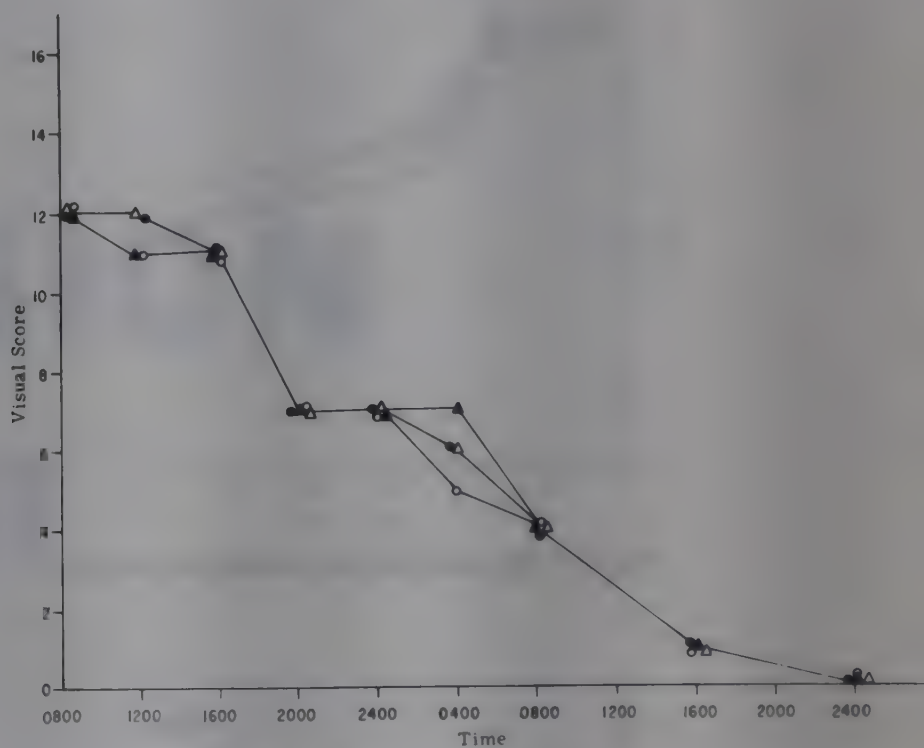


Fig. 2B - Visual score of iced ikan tuna

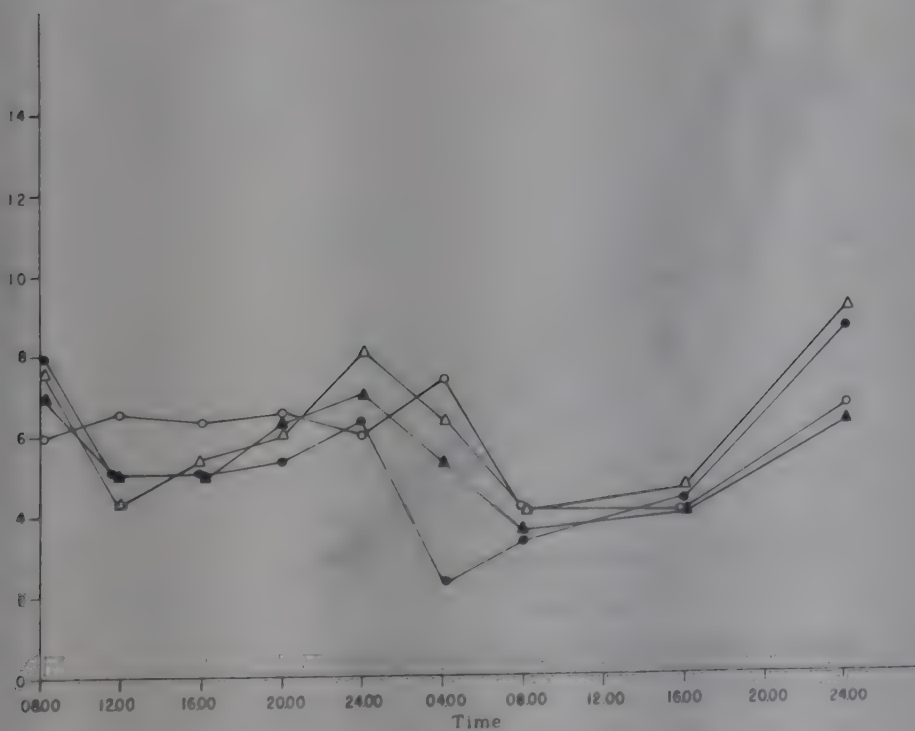


Fig. 3A - Torrymeter readings of iced ikan sardine

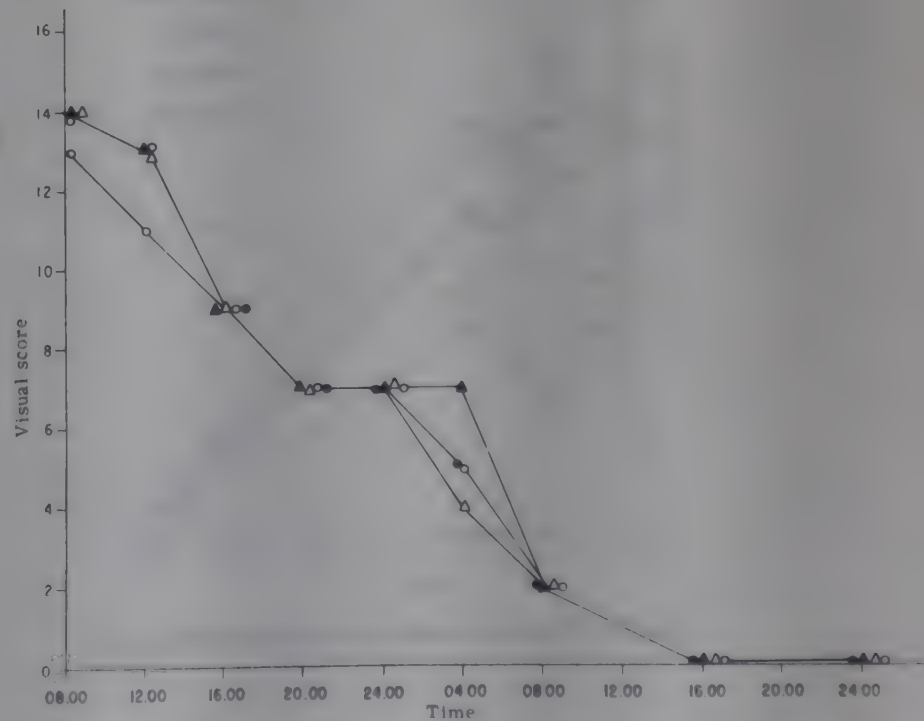


Fig. 3B - Visual score of iced ikan sardine

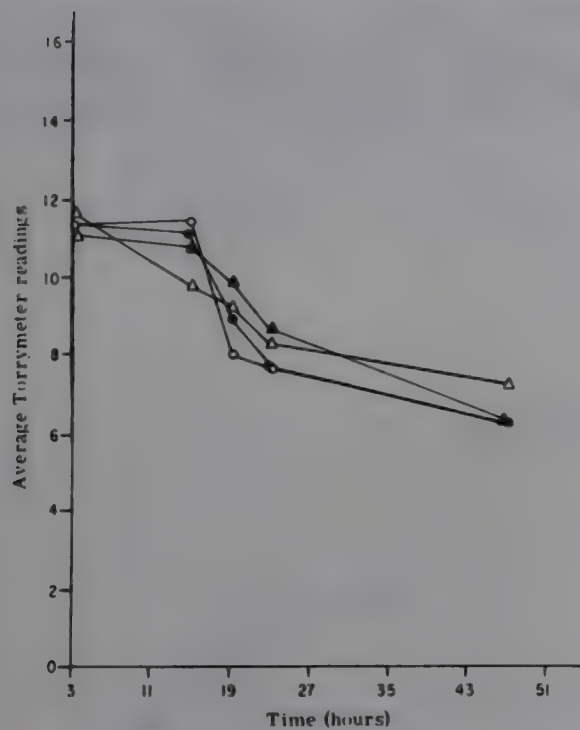


Fig. 4A - Torrymeter readings of iced ikan kerisi bali

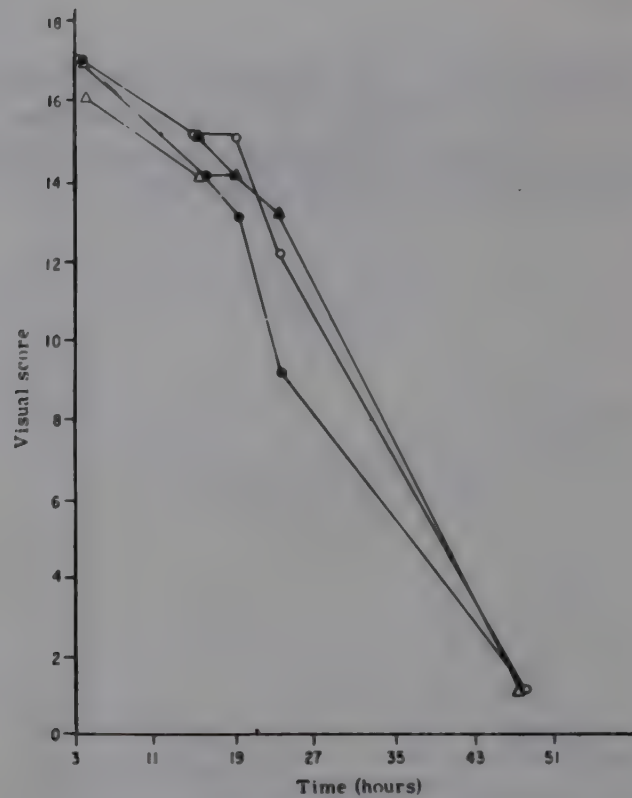


Fig. 4B - Visual score of iced ikan kerisi bali

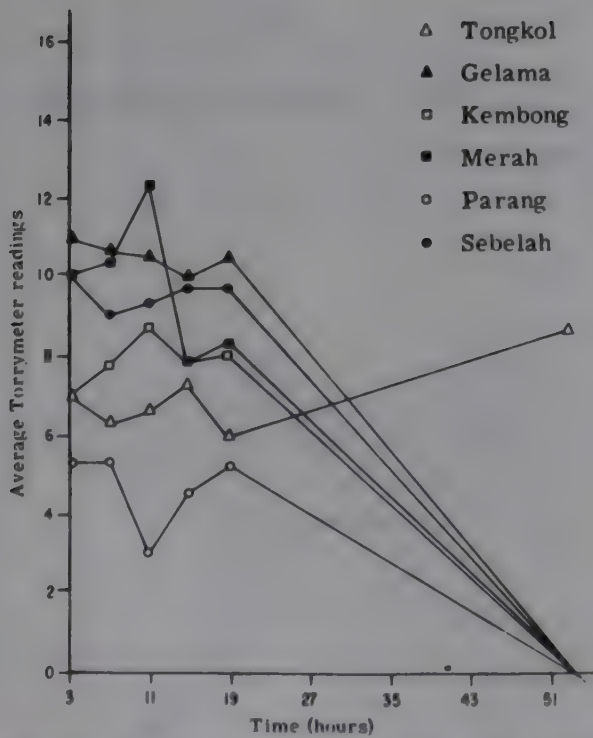


Fig 5A - Torrymeter readings of uniced fish (6 species)

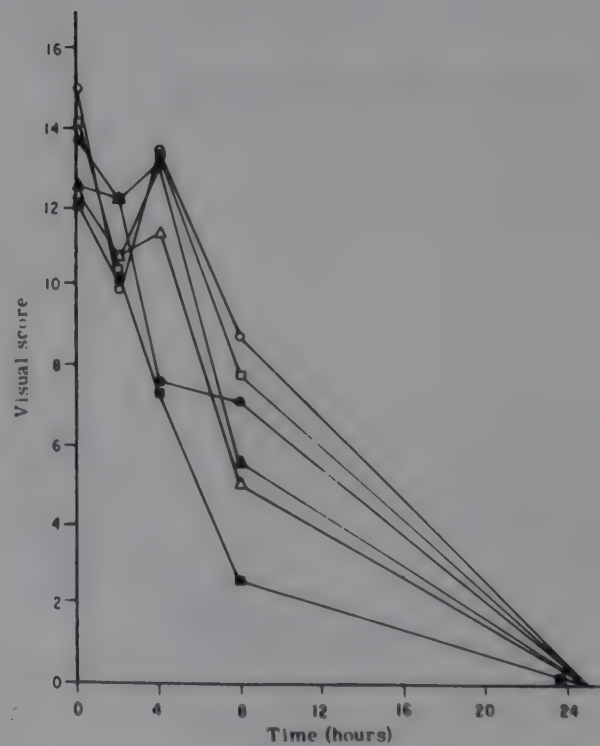


Fig. 5B - Visual score of uniced fish (6 species)

SESSION

III

Session

III

SESSION III

FISH PROCESSING

CONTENTS

PAPUA NEW GUINEA'S SEPIK RIVER SALT FISH INDUSTRY by Joe Glucksman	237
A SMOKED MINCED TILAPIA PRODUCT WITH ENHANCED KEEPING QUALITIES by Taiwo Obileye and John Spinelli	242
DEVELOPMENTAL STUDIES ON THE IRRADIATION OF FISH AND FISHERY PRODUCTS IN THE PHILIPPINES by Olympia N. Gonzales	248
MEAT SEPARATION FROM INEXPENSIVE VARIETIES OF FISH AND ITS UTILIZATION by M. N. Moorjani, Geetha Ramanathan and S. Rajalakshmi	254
STUDIES ON THE FATTY ACID COMPOSITION OF HILSA OIL by H.S. Huq and S.F. Rubbi	262
MINCED FISH TECHNOLOGY AND ITS POTENTIAL FOR DEVELOPING COUNTRIES by J.J. Matsumoto	267
THE CANNING OF INDIAN PELAGIC FISH IN A YUGOSLAVIAN CANNING PLANT by V. Perovic and E.E. Samuel	272
CHEMICAL AND TASTE PANEL TESTS ON THE MECHANICALLY SEPARATED FLESH OF SIX TROPICAL FISH SPECIES by H. Allan Bremner and P.J.I. Snell	288
UTILIZATION OF TILAPIA, A 'TRASH' FRESHWATER FISH by M.S. Ismail and A. Zain	303
RADIATION DISINFESTATION STUDIES ON SUN DRIED FISH by Mainuddin Ahmed, A.D. Bhuiya, A.M.S. Alam and S.M.S. Huda	310
TECHNOLOGICAL DEVELOPMENT OF ARTIFICIAL AND SOLAR DRYING OF FISH IN INDIA by P.K. Chakraborty	322
QUALITY CHANGES IN FISH FROM THE SOUTH CHINA SEA: FROZEN STORAGE of CHUB MACKEREL by R.G. Poulter	330
RADIATION PRESERVATION OF SEAFOODS; DEVELOPMENT OF DEHYDRO- IRRADIATION PROCESSES FOR SHRIMP (<i>PENAEUS INDICUS</i>) AND BOMBAY DUCK (<i>HARPODON NEHEREUS</i>) by Norman F. Lewis	340
REDUCING BLOWFLY SPOILAGE DURING SUN-DRYING OF FISH IN MALAWI USING PYRETHRUM by P.J. Meynell	347
HANDLING AND PROCESSING OF RAFT-FARMED MUSSELS by N.S. Boyd and N.D.C. Wilson	354
ADAPTATION OF THERMAL PROCESSING TO DEVELOP PRODUCTS FROM SMALL FISH by R. Balakrishnan Nair and A.K. Chatterjee	360

STUDIES ON THE UTILIZATION OF FISHERY WASTES FOR THE PRODUCTION OF MICROBIOLOGICAL MEDIA by S.V. Suryanarayana Rao, C.R. Saraswati and C.T. Dwarakanath	364
CHANGES IN TOTAL VOLATILE BASES DURING SALT PRESERVATION OF <i>SARDINELLA EBA</i> AND <i>CLUPEA HARENGUS</i> by M.B. Adebona	370
AN ATTEMPT TO UTILIZE FISH WASTE AND TRASH FISH IN SRI LANKA by T.S.S. Peiris	375
A NOTE ON THE DEVELOPMENT OF NEW DRIED FISH PRODUCTS by Office of Fisheries, Republic of Korea	380
FISH NOODLES by Department of Fisheries, Thailand	382
SALTED MINCED FISH TRIALS by L.W. Regier, M.B. Wojtowics, M. Fierheller and S. Varga	388
STUDIES ON TRADITIONAL METHODS OF FISH SMOKING IN THE PHILIPPINES by M A. Anenias, A.M. Mabeza, T.R. Miciano and E.C. Sison	390
APPLICATION OF GAMMA RADIATION FOR DISINFESTATION OF SUN-DRIED STRIPED MACKEREL by Ignacio S. Pablo	401

PAPUA NEW GUINEA'S SEPIK RIVER SALT FISH INDUSTRY

by

Joe Glucksman
Kanudi Fisheries Research Station
Department of Primary Industry, Port Moresby
Papua New Guinea

Abstract

After the inadvertant introduction of tilapia, *Sarotherodon mossambica*, to the mighty Sepik River it became evident that a tremendous amount of fish was being produced, surplus to local subsistence requirements, but badly needed elsewhere in Papua New Guinea. Subsequent investigation indicated that the fishery could be exploited economically only by means of 'intermediate technology' and a small successful salt fish industry was set up. Also a recent Asian Development Bank loan has made it possible to begin the rapid expansion of this fishery although the recent introduction of the aquatic fern, *Salvinia molesta*, may present serious problems.

INTRODUCTION

If fish processing is to be decentralized in Papua New Guinea it cannot employ the conventional western methods of icing, canning or freezing since the necessary energy, clean water, expertise and capital are not available, even in the administrative centres, much less in the outlying areas of the East Sepik Province (Figures 1 and 2).

This was realized in 1972 when the Department of Agriculture Stock and Fisheries (now Department of Primary Industry) conducted an extensive investigation of the potential fishery. The search for alternative methods of development then began. After examining the development of other tropical riverine fisheries, it became evident that processing by a simple method of dehydration would be most suitable and that a large part would have to be done either chemically (salting), physically (pressure) or with fueled driers because of the high rainfall.

DEVELOPMENT OF THE SALT FISH INDUSTRY

After considerable experimentation, a suitable salting and drying process was developed. It consisted of heading, scaling and splitting the fish down the back leaving the belly flap intact. The body cavity was then scrubbed clean and the fish placed between layers of salt in a polyethylene drum. A plank and stone were placed on top of the fish to exert pressure and to keep the fish completely submerged in the brine which formed. After 48 hours the fish 'struck' (i.e., the flesh was in equilibrium with a saturated salt solution) and were then sun-dried. They can however be returned to a saturated brine solution during bad weather and re-dried later. With this method, individual fishermen could preserve their fish at the point of catch and transport them to a central market at their leisure.

In mid 1975 this method was introduced to a river village and by mid 1976, twenty-five villages were producing 6.5 t of salted tilapia per month, which represents a catch of about 20 t. These salted fish were then transported to packing centres at Angoram and Pagwi where the fishermen received Kina 0.40 (U.S.\$ 0.50) per kg. The fish were then sealed in 10 kg plastic bags, with cooking instructions, and four bags were sewn up in a hessian (copra) bag for shipment to the Highlands and other inland areas.

Initially, the salted, dried fish were well received in areas where people were properly instructed in their preparation (prior to this exercise salt fish was completely unknown in inland areas) but several important drawbacks soon became evident.

1. The bones and spines of the split fish punctured the plastic bags during transit, allowing the entrance of humid air which shortened the shelf-life considerably.
2. There is a very large market for fish, deep fried in batter, which requires fillets.



Fig. 1 — Mainland Papua New Guinea.

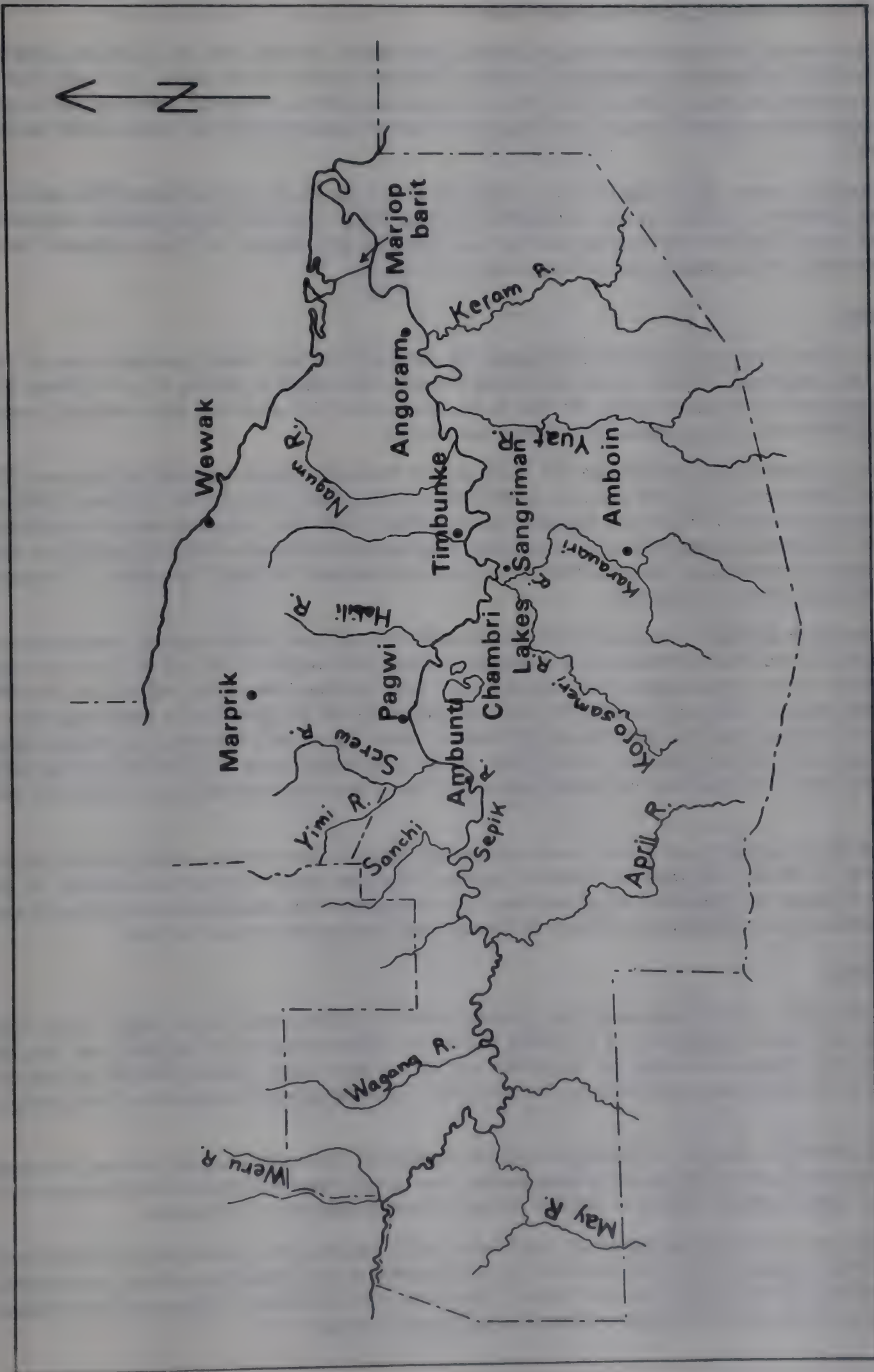


Fig. 2 — East Sepik Province.

3. Inland people were familiar only with the pre-cooked bones of canned fish; the inedible bones of the split tilapia represented a potential health hazard.

These problems were solved quite simply by processing fillets rather than split fish, in the manner described above. This method has the following advantages: it reduces the time for the fish to 'strike'; it is easier for the processor (since scrubbing the body cavity of split fish is a labourious process), it provides a more attractive offal for pig and crocodile farm use and it removes the bones which served as reservoirs for oil which readily oxidized and became rancid.

At the collection centres the fishermen now receive Kina 0.50 per kg for the sun-dried fillets which are then kiln-dried to a uniform moisture content and packed in 250 g, 500 g, 1 kg and 5 kg polyethylene bags which display the brand name 'SOLPIS' and cooking instructions. The bags are shipped in 10 kg cardboard boxes. Production is presently 2.5 t per month, representing a catch of 15 t.

The SOLPIS project

In 1976 the Asian Development Bank investigated the feasibility of, and finally granted a loan for, the development of five integrated projects in the East Sepik Province; the SOLPIS project is one of them. The fisheries sub-project share of the loan is Kina 770 000 to be spent over a 15-year period, after which it is hoped that enough capital will have been accumulated to form a cooperative.

The fisheries sub-project will encompass the Sepik and its tributaries from Ambunti to Angoram. The production target is 500 t of SOLPIS per year, i.e., 3 000 t of catch by 1983. There will be two main collection, extension and packaging centres at Pagwi and Angoram and six primary collection, extension and salt distribution points (see Figure 3). A training centre will be constructed at Angoram where fishermen will be taught those skills necessary for protracted commercial fishing and where in-service courses will be held for personnel. A biological research centre will also be built at Angoram.

From the two main packaging centres, the fish will be sold to large food wholesale/retail companies with outlets in the Highlands and inland Sepik areas. If the target production is reached at the end of year 5, the retail value of the product, based on the present recommended retail price of Kina 1.40 per kg, will be Kina 700 000 of this, the primary producer will receive Kina 250 000. This SOLPHIS will be equivalent in nutritional value to 1 500 t of imported canned mackerel, which presently retails at more than Kina 1 000 per t. The future import and consumer savings will almost certainly be far greater as the production costs of SOLPHIS will rise along normal inflationary lines, while the price of canned mackerel will be affected by political factors such as the 200-mile EEZ.

The fisheries sub-project will also include credit and supply facilities, for example, salting vessels, salt and filleting knives will be distributed from the extension centres; long-term credit will also be available for the purchase of nets. Although the limitations of gill-nets have been recognized and considerable research has already been done on alternative gear, a floating set with the 10.16 mm mesh remains the best gear to date.

*Problems with *Salvinia**

Some time after 1972, the noxious water fern *Salvinia molesta* was introduced to the Sepik. As the weed reproduces almost exclusively vegetatively, it is usually considered to have been spread by hand over long distances for 'ornamental' purposes and then by navigation and drift within a river system. *Salvinia* had reached epidemic proportions in some parts of the Sepik by December 1977, interfering with navigation and the setting of nets.

None of the chemical, physical or biological controls, employed with only marginal success elsewhere, seems feasible for the Sepik, primarily because of topography. It is thought that the extreme fluctuations in water level in the original South American habitat of *Salvinia* prevent it from causing too much damage.

Normally there are similar fluctuations in the Sepik but in 1977, the first year *Salvinia* became detrimental, these fluctuations did not occur. It is hoped that when the Sepik returns to its normal high and low water regime, the *Salvinia* population will fall below the point where it interferes with the fishery (Johnstone, unpublished). Meanwhile, the search for methods of control applicable to the Sepik continues.

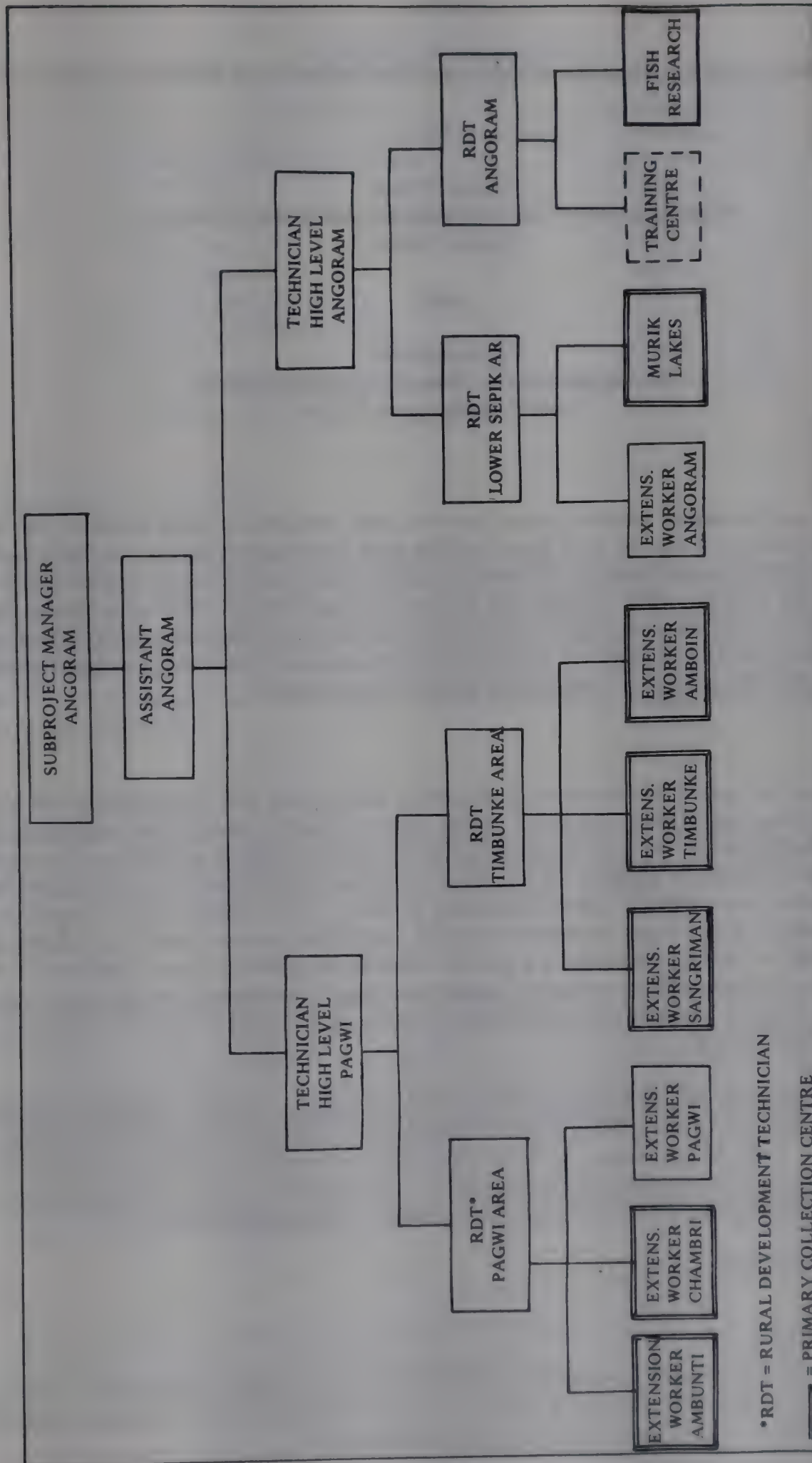


Fig. 3 — Organization of Asian Development Bank Fish Production and Processing.
 Sub-Project, East Sepik Province.

A SMOKED MINCED TILAPIA PRODUCT WITH ENHANCED KEEPING QUALITIES

by

Taiwo Obileye
Nigerian Institute for Oceanography and Marine Research
Lagos, Nigeria

and

John Spinelli
U.S. Department of Commerce, NOAA, NMFS
Seattle, Washington, U.S.A.

Abstract

A stable and palatable smoked tilapia product with enhanced keeping qualities was prepared from minced tilapia flesh. The minced flesh was modified with a mixture of salt and sodium tripolyphosphate and stabilized with potassium sorbate. Products, smoked prior to reforming into sheets and hot-smoking at 70°C to moisture contents of 25 percent and 45 percent and stored at 20°C at a relative humidity of 76 percent, were stable against mould growth for at least 60 days with the addition of the potassium sorbate. Smoking to these moisture contents at a maximum temperature of 70°C did not significantly reduce the nutritional value of the protein as measured by available lysine values.

INTRODUCTION

In many parts of the world, the problem of preserving fish rapidly and inexpensively still remains a major deterrent to fully utilizing local fishery resources. Where there is a lack of freezing and canning facilities, salting, drying and smoking still represent the most convenient but not always the most satisfying ways of preserving fish. It is estimated that where modern facilities do not exist, 50 percent of the fish that is salted and/or dried is lost either to decomposition or rodent and insect infestation (Cutting, 1962; Denaut, 1975). Highly salted fish can also have the disadvantage of not being universally accepted, particularly when it needs to be desalted prior to use (Del Valle *et al.*, 1968). In Nigeria, smoking is a popular method for preserving some species of fish, eg., tilapia. This freshwater species is hard-smoked (generally whole) to a brittle consistency and consumed directly as soups and stews. In humid tropical climates even hard-smoked products are subject to the usual losses incurred by insect and microbiological attack.

In one form or another, salted, dried and smoked fish are widely accepted and would contribute more to food needs if their losses during the various stages of distribution could be reduced. In the work presented here, we take advantage of some of the virtues of basic processing techniques in producing, from blended, minced flesh, a smoked product whose organoleptic characteristics can be modified to suit regional preferences but which still retains enhanced keeping qualities and is amenable to simple packaging procedures.

MATERIALS AND METHODS

Fish

Tilapia (*T. aureus*) were reared in 90-gallon circular tanks maintained at temperatures ranging from 75 to 85°F (24 to 30°C). The fish were fed for 9 months on a wet pelletized diet consisting primarily of mill run (wheat by-products) (Table 1) and reared to a size of 150-500 grammes.

Table 1

Composition of tilapia diet

Composition	Percent of diet
Mill run (wheat by-products)	47.0
Fish meal	11.7
Corn distillers solubles	4.6
Wheat germ	4.0
Tuna viscera	7.8
Choline chloride (70%)	0.2
Vitamin, mineral mix ^{a/}	1.0
Water	23.7

a/ Halver, 1972

Processing and preparation for smoking

The fish were headed, eviscerated, washed and minced by passing through a Yanigiya flesh separator^{1/}. The yield of flesh was 45 percent. The proximate composition of the minced flesh was 79.1 percent moisture, 17.9 percent protein, 2.0 percent fat, and 1.1 percent ash. The minced flesh was partially solubilized with salt and sodium tripolyphosphate (NaTPP) by addition of 10 ml of a solution containing 10 g of salt, 2 g of NaTPP and 1.1 g of potassium sorbate per 100 ml per 100 g of fish. The flesh was then mixed in a Hobart food mixer^{1/} or a Waring Blender^{1/} for 2 minutes. Prior to smoking, the modified flesh was moulded into sheets by filling into a wooden mould (20 x 15 x 0.5 cm).

Smoking

The formed tilapia sheets were placed on a zinc-coated wire mesh (1 cm) screen and smoked at 30°C for 2 hours and then at 70°C, for an additional 3 hours. At that time the moisture content was about 40 percent. Smoking at 70°C, for 12 hours reduced the moisture content to about 25 percent.

Humidification of the products

The smoked fish were subdivided into pieces that could be passed through 0.3 cm mesh screening for determining the effect of storage at various relative humidities. Three to five grammes were placed in polystyrene Petri dishes (15 x 90 mm) and equilibrated in desiccator jars at 20°C. Saturated salt solutions were used to produce the various levels of constant relative humidity (Rockland, 1960) in the jars. The absorption isotherm was prepared by first equilibrating the samples for 12 days at 0 percent RH in a vacuum desiccator (LaPuza, 1966) and then re-equilibrating at various relative humidities.

The equilibrium moisture content was determined by analysis of samples held in a vacuum oven (737 mm Hg, 70°C) to constant weight (Rockland, 1960).

Available lysine

Available lysine was determined (Carpenter, 1960) in raw, smoked and heated tilapia to provide an estimate of the reduction of nutritional value of the protein during processing.

^{1/} Trade names referred to in this publication do not imply endorsement of commercial products.

RESULTS AND DISCUSSION

Product characteristics

Modifying the minced fish with the salt and NaTPP produced homogenous cohesive mass that could be formed easily into shapes of desired dimensions. Smoking to a moisture content of about 45 percent produced a pliable but hard pellicle that resisted crumbling when handled. This product had a chewy consistency resembling beef jerky. At 25 percent moisture, the product acquired a brittle characteristic resembling the smoked whole product currently consumed in Nigeria. Although decreasing the moisture content from 45 to 15 percent increased the fat content to about 4.0 percent and 8.0 percent respectively, only slight evidence of rancidity was detected in the product during storage.

Neither product was excessively salty to the taste. The product smoked to 45 percent moisture contained about 2.5 percent salt and that smoked to 25 percent moisture about 3.4 percent salt. Salt in the aqueous phase of the product with 45 percent and 25 percent moisture content was about 5.3 percent and 12.0 percent, respectively. This relatively low moisture content coupled with the high salt and sorbate contents in the water phase should make these products relatively stable against bacteriological attack. Although the resistance of these products to spoilage bacteria was not investigated, visual signs of microbial growth were not evident during storage up to 60 days when held at ambient temperatures of 20-25°C and at a relative humidity of 76 percent.

Effect of potassium sorbate on mould growth

Unpackaged products, which had not been treated with potassium sorbate and had been smoked to a moisture content of 45 percent, were extremely liable to attack by mould. Typically, uninoculated products showed visible evidence of mould growth after 4 to 5 days of storage at ambient temperature (23°C). However, products smoked to about 25 percent moisture content and kept in polyethylene (2 mil) bags and Scotchpack containers (laminated polyethylene/polyester) had visible mould growth after 14 days of storage at ambient temperature.

The effect of potassium sorbate in inhibiting mould growth in unpackaged products was demonstrated by holding the products in controlled humidities for 60 days. The results of these experiments are given in Table 2. Untreated products smoked to a moisture content of 45 percent showed mould growth after 5 days when held at an RH of 44 percent and in 4 days when held at RH 76. With sorbate no mould growth was observed for 60 days at an RH of 44 percent and for 52 days at RH 76 percent. With no added sorbate, products smoked to a moisture content of 25 percent showed no mould for 20 days when stored at 44 percent RH but when stored at an RH of 76 percent mould growth appeared after 5 days of storage. The same products containing sorbate showed no mould growth for at least 60 days when held at 44 percent and 76 percent RH. These results demonstrate the effectiveness of sorbate in the products, particularly in humid climates when RHs of 76 percent and over are frequently encountered.

Table 2

Effect of potassium sorbate on the growth of mould in smoked tilapia flesh modified with salt and sodium tripolyphosphate and stored at 23°C at relative humidities of 44 and 76 percent.

Treatment	Initial Moisture (%)	First observation of mould growth at:	
		RH 44% (Days)	RH 76% (Days)
No sorbate	45	5	4
With sorbate ^{a/}	45	> 60	> 60
No sorbate	25	20	5
With sorbate ^{b/}	25	> 60	> 60

a/ 0.25% sorbate in product after smoking

b/ 0.37% sorbate in product after smoking

The ability of the smoked product to absorb moisture and thereby to increase its susceptibility to microbiological spoilage is shown in Figure 1. The absorption isotherm shows that the product will equilibrate to a moisture content ranging from 20 to 25 percent. A surface equilibrium moisture in excess of 30 percent might quickly be established in areas of high RH but even at this relatively high moisture level, our data show that the product is stable to mould growth.

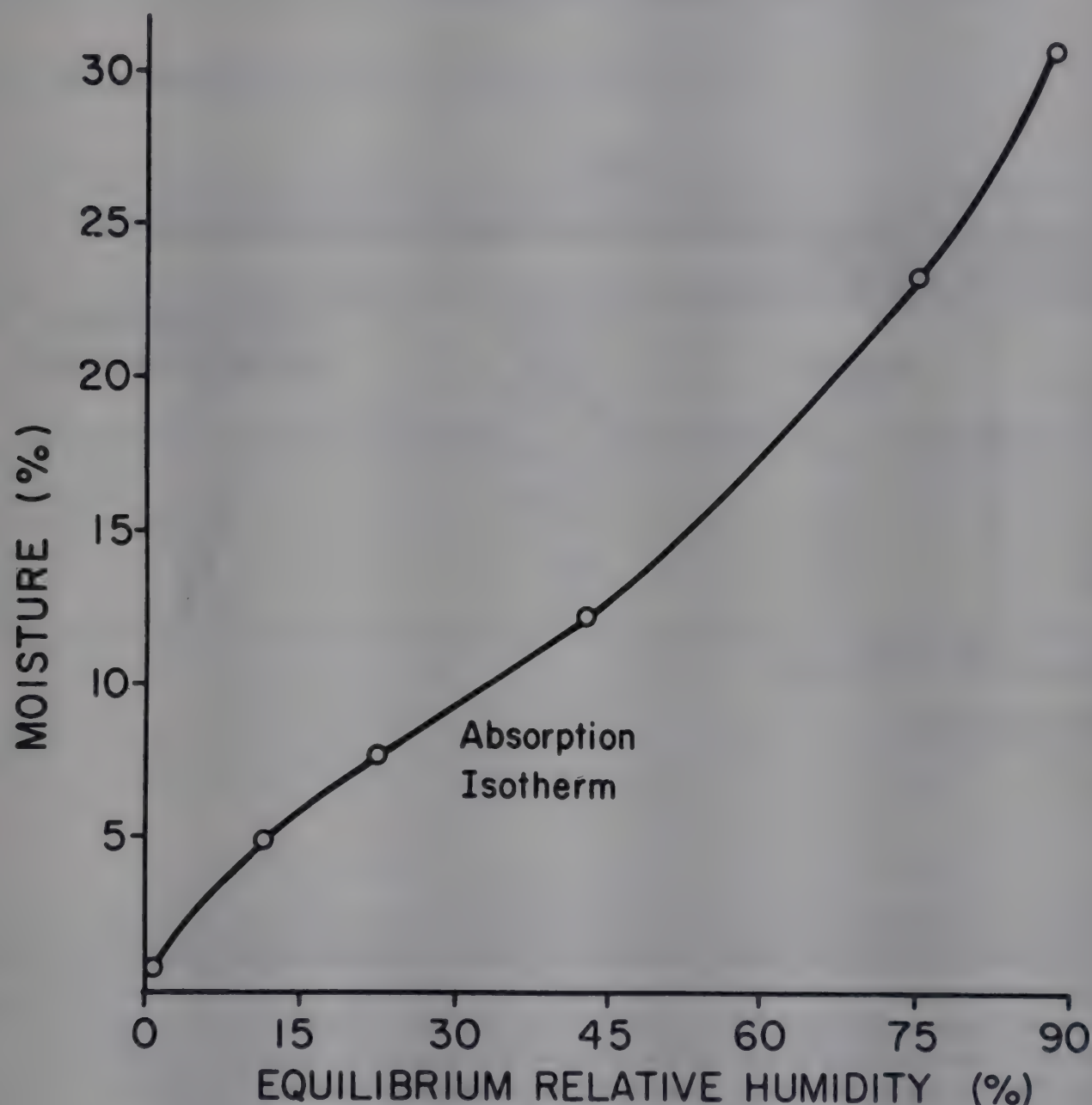


Figure 1 — Moisture absorption curve for smoked minced tilapia modified with salt and sodium tripolyphosphate.

Effect of smoking on available lysine

An assessment of the nutritional quality of the protein in the smoked product was made by determining available lysine before and after smoking. The data presented in Table 3 shows that smoking to a moisture content of 52 percent reduced the available lysine by 17.7 percent and there was an additional slight reduction in available lysine before and after smoking. The data presented in Table 3 shows that smoking to a moisture content of 52 percent minced tilapia was heated in an air oven at a temperature simulating that used in smoking, the available lysine was reduced by only 8.9 percent. When liquid smoke was added to the product before heating, lysine was again

reduced by 17.8 percent indicating that reactive substances in both the natural smoke and the liquid smoke react with the epsilon amino group of the lysine. Even with these losses, the amount of available lysine in the final smoked product is equivalent to that of many animal proteins and in excess of most cereal proteins; this indicates no significant reduction of the nutritional quality of the protein.

Table 3

Effect of heating and smoking on the available lysine content of tilapia flesh modified with salt and sodium tripolyphosphate

Treatment	Moisture (%)	Available lysine (g/16 g N)	Loss in available lysine resulting from treatment (%)
Raw	79	8.77	—
Smoked	52	7.22	17.7
Smoked	22.6	7.11	18.9
Heated ^{a/}	22.0	8.0	8.9
Heated ^{b/}	22.0	7.2	17.8

a/ Air oven 70°C for 16 hours

b/ With liquid smoke

CONCLUSIONS

Our work suggests that advantage can be taken of the technology of minced fish preparation and the preservation properties of smoking, salting, and sorbate addition to produce a smoked tilapia product with enhanced keeping qualities. Minced tilapia products with 2 percent added salt and smoked to moisture contents of approximately 25 and 45 percent were organoleptically acceptable for at least 60 days when stored at relative humidities as high as 76 percent. Control samples stored under similar conditions were considered spoiled due to mould growth after 4 days. The processing conditions used in our experiments showed that the maximum loss of available lysine was approximately 18 percent. Modification of the products with NaTPP and salt coupled with the simple preservation techniques of smoking and salting and the addition of sorbate also allows for adjusting the physical and the organoleptic properties of the products to suit regional taste and preferences. Packaging the product in simple film pouches such as polyethylene would offer some protection against slow changes in atmospheric humidity, but the primary function of packaging would be to protect against animal and insect infestation.

The work reported here was carried out as a cooperative study at the Utilization Research Division, Northwest and Alaska Fisheries Center, Seattle, Washington, U.S.A.

REFERENCES

- Carpenter, K.J., Estimation of available lysine in animal protein food. *Biochem.J.*, 77, 606-10
1960

- Cutting, C.L., The influence of drying, salting, and smoking on the nutritive value of fish. *In Fish in nutrition*, 1962 edited by E. Heen and R. Kreuzer. London, Fishing News (Books) Ltd., pp. 161-71
- Del Valle, F.R. and Gonzalez-Inego, A quick salting process for fish. *Food Technol. Aust.*, 22:1135-8
1968
- Denaut, N.J., The world food shortage versus population explosion. *Prof. Nutr.*, 7(3):2-5
1975
- Halver, J.E. (Ed.), Fish nutrition. New York, Academic Press, 713 p.
1972
- LaPuza, T.P., J.F. Maloney and M. Karel, Autoxidation of methyl linoleate on freeze-dried model systems.
1966 2. Effect of water on cobalt catalyzed oxidation. *J. Food Sci.*, 31:885-9
- Rockland, L.B., Saturated salt solutions for static control of relative humidity between 5°C and 40°C. *Anal. Chem.*, 32:375-6
1960

DEVELOPMENTAL STUDIES ON THE IRRADIATION OF FISH AND FISHERY PRODUCTS IN THE PHILIPPINES

by

Olympia N. Gonzales
National Institute of Science and Technology
National Science Development Board
Manila, Philippines

Abstract

The use of gamma radiation in the preservation of fish and fishery products has shown that exposure to 100 and 200 krad increased the shelf-life of deboned milkfish (*Chanos chanos* Forskal), crabmeat and shrimps stored under refrigerated conditions.

Examinations made on commercial samples of dried and smoked hasa-hasa (*Rastrelliger brachysoma*), dried and smoked tunsoy (*Sardinella fimbriata*) and steamed sinaing na tulingan (*Auxis thazard*) showed high microbial counts. In laboratory-prepared samples inoculated with 10^7 cells of *Salmonella choleraesuis*, *S. paratyphi A*, *S. typhimurium* and *Escherichia coli* per g of sample and irradiated at doses of 0 to 400 krad, *S. typhimurium* was found to be the most radiation-resistant. Resistance of the organisms was less in the dried and steamed fish. Dried, smoked and steamed fish with a salt content of 6 percent and below can be protected from *Salmonella* and *E. coli* by irradiation. No changes in organoleptic properties were detected in either dried, smoked or steamed fish irradiated with doses up to 500 krad.

INTRODUCTION

A serious problem faced by a large proportion of the world's population is the production and preservation of sufficient food to combat hunger and malnutrition. In the Philippines, as in many developing countries, many people subsist on poor and inadequate diets with consumption of protein below recommended levels. This situation is further aggravated by the steady increase in population.

The country, however, is well endowed with fishery resources. The total fish production is reported to have increased from 667 202 tons in 1965 to 1 336 803 tonnes in 1975 (Bureau of Fisheries and Aquatic Resources, 1975). The Government is harnessing all its resources to encourage development of the fishing industry. It has also been encouraging foreign capital to enter the country through an improved investment climate.

The fishing industry has now become one of the most important industries in the Philippine economy and fish is an important source of nutrition for the Filipino people. Together with rice, fish serves as the most essential component of the Filipino diet. A recent statistical survey showed that fish supplied about 57 percent of the protein consumed by the population (Bureau of Fisheries and Aquatic Resources, personal communication).

The importance of fish in the overall food supply cannot be overemphasized. An important aspect, besides increased production, is the improvement of the handling, processing, storage and distribution of fish and its products to avoid much of the present wastage. In coastal fishing areas, a great deal of the produce is either salted, dried or smoked. In some cases, fish are used in the manufacture of fermented paste (bagoong) and sauce (patis). The products are finally transported by rail, ship or road to central markets where they are sold to wholesalers and retailers. Dried fish are often too salty and unpalatable. In most instances, when they reach the consumer, they are discoloured and have a moist appearance; they may even become infested with worms and insects. Smoked fish easily becomes mouldy and develop a characteristic rancid flavour. Unscrupulous dealers in the open market tend to mask these defects by brushing the fish with coconut oil mixed with an orange-red food colour.

A survey of several types of processed food items including dried, smoked and steamed fish in the Philippines revealed a high incidence of *Staphylococcus aureus*, coliforms, *Salmonella* and *Shigella*, yeasts and moulds (Karganilla, 1975). The occurrence of these pathogens was thought to have resulted from poor handling, processing, storage and distribution practices. During the rainy summer months (April to August), the temperature and relative humidity can be as high as 34°C and 92 percent. These climatic conditions favour microbial growth and enterotoxin production in local foodstuffs which could have been responsible for sporadic local outbreaks of food-borne disease.

Food irradiation has now reached a stage where some practical application is possible. The potential usefulness of this process in improving the microbiological quality and extending the storage life of agricultural and fishery products suggests the need for local developmental work in this field. For irradiation activities have now gained momentum in the Philippines. This paper reviews present research efforts funded by the International Atomic Energy Authority (IAEA), on the radiation preservation of fish and fishery products with special reference to their microbiological qualities.

EFFECT OF GAMMA RADIATION ON THE PRESERVATION OF FISH AND FISHERY PRODUCTS

This study was undertaken at the Bureau of Fisheries and Aquatic Resources under IAEA Research Contract No. 1495/RI/RB. The results were presented at the 1977 Bombay Research Coordination Meeting on Radiation Preservation of Asian Fish and Fishery Products (Guevarra, 1977), and will be briefly discussed in this paper.

Deboned milkfish

In the Philippines, more than 90 percent of the fish pond production consists of milkfish (*Chanos chanos* Forskal). In 1973, production was reported to be close to 100 000 tonnes. Of these about 8 percent were frozen and exported, but the majority were sold locally as fresh fish. A small quantity was also sold as dried, smoked and deboned fish products (Bureau of Fisheries and Aquatic Resources, 1973). Deboned milkfish, sold raw or smoked, has become a popular food product locally. The deboning process requires much human handling, thus making the fish prone to contamination.

Three batches of the deboned fish, packed and sealed in polyethylene bags, were each irradiated at 0,100 and 200 krad. Unirradiated controls and irradiated samples were stored at room temperature (20-30°C) and at 0-5°C. The samples were examined initially and then weekly for organoleptic quality and total bacterial count. Unirradiated samples stored at room temperature became spoiled after 2 days' storage in contrast with 3 days for the irradiated products. A distinct advantage of irradiation was shown when the samples were stored at 0-5°C. The control samples were considered to be spoiled after 14 days whereas the irradiated ones remained acceptable for one month; this was confirmed by total bacterial counts which were significantly higher in the controls during storage.

Crab meat

Blue crab (*Neptunus pelagicus*) is a common item sold in local market stalls. It is steamed and its meat is eaten directly or used as an ingredient in many traditional recipes.

Fifty g of steamed meat were packed and sealed in polyethylene bags. From these, 3 batches of 9 bags each were irradiated on ice at 0,100 and 200 krad. All the samples were stored at 0-5°C and examined initially and then weekly for total bacterial count and organoleptic properties (texture, colour, flavour and overall acceptability). The samples were likewise analysed for coliforms and *Salmonella-Shigella* counts. From the organoleptic assessment, the unirradiated control was judged to be spoiled after 7 days' storage with the development of distinct ammoniacal odour, biting flavour and soft-texture. The irradiated samples were still acceptable even after 4 weeks of storage.

The results of microbial analysis indicated a rapid increase in the total bacterial count of the unirradiated samples during storage. Significantly lower counts were obtained on the irradiated samples. Initially, the irradiated crab meat gave negative results for *E. coli* and *Salmonella-Shigella*. The control samples were found to be positive for *E. coli*.

Shrimps

Shrimps are prized food items in the country and are consumed after steaming. They are used as ingredients in many traditional dishes. Like any other fish and shellfish, they spoil easily when allowed to stand at room temperature.

This study used shrimp of the genus *Penaeus*. The samples were thoroughly washed and beheaded. Peeled and unpeeled shrimp were packed separately and sealed in polyethylene bags, irradiated at 0,150 and 200 krad and stored at 0-5°C. A significant reduction in the total bacterial count was obtained in the irradiated samples. The control samples were judged to be spoiled after 3 weeks of storage as compared to 6 weeks for the irradiated ones. The latter samples gave negative results for *Staphylococcus*, *Salmonella*, *Shigella* and coliforms. The unirradiated shrimps were positive for *Escherichia* and *Staphylococcus*.

It is seen from the above studies that the shelf-life of deboned milkfish, steamed crab meat and beheaded shrimps (peeled and unpeeled) can be prolonged by irradiation in combination with refrigerated storage at 0-5°C. No distinct advantages were observed, however, with any of the products if they were stored at room temperature.

ELIMINATION OF THE RISK RESULTING FROM PATHOGENIC MICRO-ORGANISMS IN DRIED AND SMOKED FISH BY GAMMA IRRADIATION

This study was conducted by the author at the National Institute of Science and Technology, National Science Development Board under IAEA Research Contract No. 1737/RI/RB. Fishery products used in this investigation included dried and smoked mackerel or hasa-hasa (*Rastrelliger brachysoma*), dried and smoked heering or tunsoy (*Sardinella fimbriata*), and steamed sinaing na tulingan (*Auxis thazard*). Compared with other protein foods these foodstuffs are cheap and are very popular.

Commercial samples of the above mentioned products, picked randomly in the open markets, were analysed for moisture and salt and examined microbiologically for total bacterial count, *Staphylococcus*, coliforms, *Salmonella-Shigella*, yeasts and moulds. The results (Table 1) indicated a high incidence of pathogens in these products; this could be attributed mainly to poor processing and handling techniques. However, neither coliforms nor *Salmonella-Shigella* could be detected in the dried fish probably because of its high salt content (15 percent). At this salt level, the dried fish is too salty and unpalatable.

Table 1

Moisture and salt content and bacterial counts of commercial fishery products

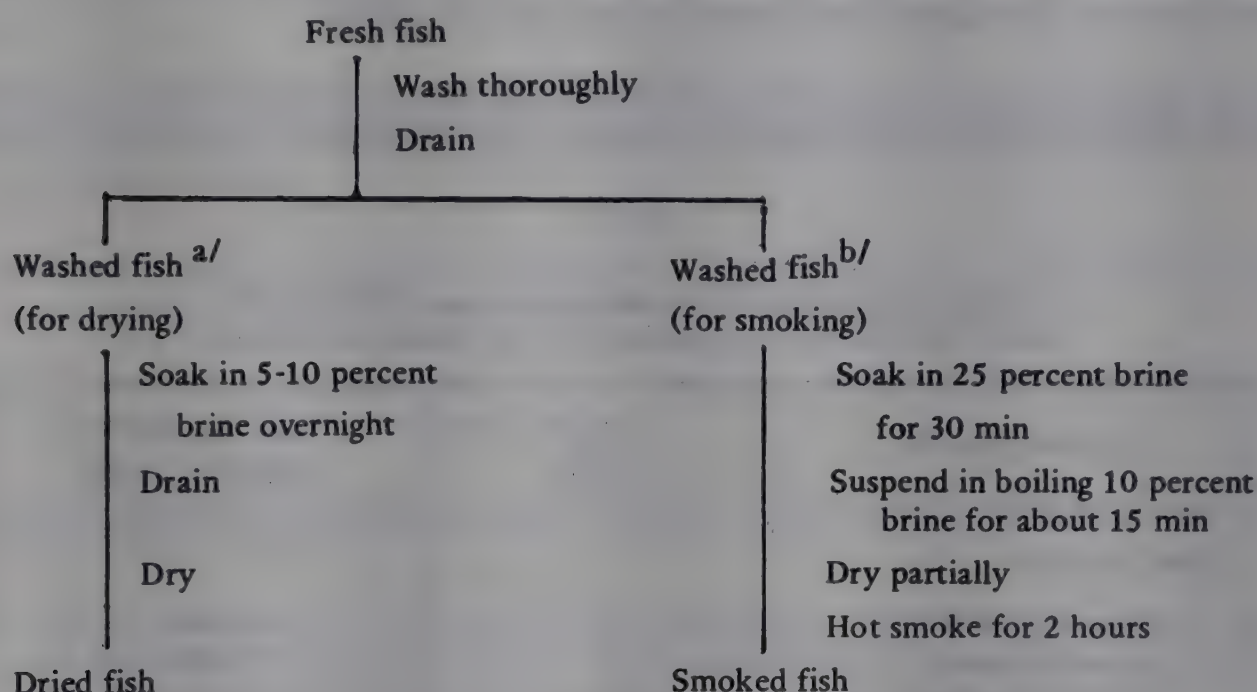
Product	Moisture (%)	NaCl (%)	TPC (Count/g)	<i>Salmonella-Shigella</i> (count/g)	<i>Staphylococcus</i> (count/g)	Coli-forms (MPN/g)	Yeasts and Moulds (count/g)
Dried hasa-hasa	37	15	a/	—	58	—	30
Smoked hasa-hasa	58	5.3	a/(10 ⁴)	—	88x10 ³	—	12x10 ²
Dried tunsoy	39	8.6	193x10 ³	—	58	—	350
Smoked tunsoy	61	2.3	173x10 ⁶	23	a/(10 ³)	13	a/(10 ³)
Sinaing na tulingan	50	3.5	a/(10 ³)	2,400	a/(10 ³)	9 200	1 080

a/ Too numerous to count

Sinaing na tulingan is prepared commercially as follows:

Eviscerated fish are washed well, mixed with salt (5 percent based on the weight of the fish) and arranged in clay pots lined with banana leaves. Pieces of kamias (*Averrhoa bilimbi* Linn.) are placed on top of the fish, a little water is added, the pot is covered and then heated over a low fire for about one hour.

The traditional method of processing dried and smoked fish is shown by the following flow-chart:



a/ Large fish are split into butterfly fillets; the gills and entrails are removed

b/ Large fish are eviscerated and smoked whole

Samples of various fish products were prepared in the laboratory following the above procedures. Inoculation studies were conducted to determine salt content and/or radiation dose necessary for a significant reduction in the counts of *Salmonella* and *Escherichia coli*.

In view of its negative results obtained for *Salmonella* in the commercial samples of dried hasa-hasa, a study was conducted to determine the effect of salt on the growth of this pathogen. Samples of varied salt content* (3.3 to 10.5 percent) were inoculated with 10^7 cells of *S. paratyphi A* per g and viable counts were made after 24 hours' incubation at 37°C . Bacterial growth was supported up to 6 percent salt; at salt levels of 8 percent and above, the organism failed to survive.

Investigations on the combined effects of various radiation doses and salt contents of 5 to 6 percent in dried fish indicated a marked quantitative reduction in the numbers of *E. coli* and *Salmonella* (*S. choleraesuis*, *S. paratyphi A* and *S. typhimurium*) with increase in radiation dose. *Salmonella* and *E. coli* failed to survive at radiation levels of 200 and 300 krad respectively. Results of microbial analysis also indicated that salt concentration had a marked effect on the reduction of *Salmonella*; 6 percent salt exerted a significant bactericidal effect apart from that of the radiation treatment. Dried hasa-hasa and tunsoy, with a salt content of 6 percent and below, can be protected from *Salmonella* by irradiation. This could lead to the development of a much more acceptable products as salt content of 8 percent and above results in very salty and unpalatable products.

The calculated D_{10} values for the three serotypes of *Salmonella* and *E. coli* in the dried and smoked fishery products and in sinaing na tulingan are given in Table 2.

The three *Salmonella* serotypes and *E. coli* were more sensitive to radiation treatment in the smoked fish than in the dried fish and in sinaing na tulingan. This may be attributed to the differences in the levels of chemical constituents with bactericidal effects present in the products. The occurrence of phenolic constituents in the smoked product may have contributed to the greater sensitivity of the organisms to radiation treatment. In addition the smoked fish had higher moisture contents (58 to 64 percent) compared with the dried fish (37 to 43 percent) and sinaing na tulingan (25 to 50 percent).

The above findings suggest an inactivation factor of 10^5 for the organisms tested in the dried, smoked and steamed fishery products. The suggested irradiation doses are shown in Table 2.

Results of acceptability tests on the above products irradiated at 500 krad showed no changes in organoleptic properties. Both the irradiated and unirradiated controls were considered acceptable by the panel.

Table 2

Relative sensitivity of the three serotypes of *Salmonella* and *E. coli* in dried and smoked fish and sinaing na tulingan

Product/organism	D ₁₀ (krad)	Dose for 10 ⁵ -fold reduction (krad)
Dried hasa-hasa		
<i>S. paratyphi A</i>	77	390
<i>S. choleraesuis</i>	21	110
<i>S. typhimurium</i>	90	450
Smoked hasa-hasa		
<i>S. paratyphi A</i>	15	80
<i>S. choleraesuis</i>	12	60
<i>S. typhimurium</i>	33	170
Dried tunsoy		
<i>S. paratyphi A</i>	36	180
<i>S. choleraesuis</i>	22	110
<i>S. typhimurium</i>	50	250
<i>E. coli</i>	57	285
Smoked tunsoy		
<i>S. paratyphi A</i>	15	75
<i>S. choleraesuis</i>	16	80
<i>S. typhimurium</i>	20	100
<i>E. coli</i>	47	235
Sinaing na tulingan		
<i>S. paratyphi A</i>	42	210
<i>S. choleraesuis</i>	66	330
<i>S. typhimurium</i>	89	445
<i>E. coli</i>	53	265

CONCLUSION

In the light of the above results and from similar studies (IAEA, 1968; Hanneson, 1972; Loaharanu, 1973; Pablo, 1977) conducted in many developed and developing countries of the world, radiation processing of fish and fishery products could be considered effective. The process would not only eliminate the risk resulting from pathogens but also would destroy many of the spoilage agents like bacteria, insects, parasites, moulds and yeasts which are known to be the main cause of food losses in the developing countries.

REFERENCES

- Guevarra, G., Studies on the effect of gamma radiation on the preservation of fish and fishery products. Report 1977 on a Research Coordination Meeting on Radiation Preservation of Fish and Fishery Products. *Food Irrad. Newsl.*, 1(3):6-8
- Hanneson, G., Objectives and present status of irradiation of fish and seafoods. Food International Project in the 1977 Field of Food Irradiation, Karlsruhe, West Germany. *Irrad. Inf.*, (1): 28-64
- IAEA, Elimination of harmful organisms from food and feed irradiation. In Proceedings of the Panel, Zeist, 1968 Netherlands, 1967. Vienna, IAEA, 118 p.
- Karganilla, J.S., E.T. Mortel and N.S. Navarro, Microorganisms of public health significance in some ready-to-eat local foods (in press)
- Loaharanu, P., Gamma irradiation of fishery products in Thailand with special reference to their microbiological 1973 and entomological aspects. In Aspects of the introduction of food irradiation in developing countries. Proceedings of the Symposium, Bombay, 1972. IAEA, Vienna, pp. 21-32.
- Pablo, I.S., Radiation disinfestation of some local sun-dried fishery products. Report and Research Coordination 1977 Meeting on Radiation Preservation of Fish and Fishery Products. *Food Irrad. Newsl.*, 1(3):5-6
- Philippines, Bureau of Fisheries and Aquatic Resources, Fisheries statistics of the Philippines. *Fish. Stat. Philipp.*, 1975 (1975):115 p

MEAT SEPARATION FROM INEXPENSIVE VARIETIES OF FISH AND ITS UTILIZATION

by

M.N. Moorjani, Geetha Ramanathan and S. Rajalakshmi
Central Food Technological Research Institute
Mysore, India

Abstract

The separation of meat from small and inexpensive varieties of fish and its use in various processed fish products has attracted increasing attention during recent years and a lot of work is being done in different parts of the world.

This review discusses:

- (1) The principles behind the separation of meat;
- (2) Use of various types of meat/bone separator;
- (3) Percentage recovery of meat from various fish, characteristics of the fish used for the purpose;
- (4) Residual bone content in the separated meat;
- (5) Varied preparations from the raw material;
- (6) Specifications to ensure quality of the product and to prevent health hazards particularly with reference to its microbiological quality;
- (7) Utilization of by-products after the separation of meat.

INTRODUCTION

Extensive research, conducted in different parts of the world, has revealed the high nutritive value of the proteins from different fish and other edible fauna which, in many cases, is of about the same order as that of milk proteins. The fish proteins are not only well balanced in regard to most of the essential amino acids, but they are also generally rich in 1-lysine which is deficient in most cereals, millets, root crops, etc., which form the bulk of the diets of more than two thirds of the population of the world. It has now been well established that supplementation of diets, based on cereal and similar products, with fish, even at low levels, greatly improves the growth-promoting value.

The immediate problem in many countries is the conservation and better utilization of the abundant seasonal catches of fish. In a country like India, which has a few thousand miles of coastline, the seasonal catches of certain varieties of fish are so abundant and the storage facilities so poor that, during such seasons, large quantities of fish spoil before they can be marketed. Among these, a number of varieties of fish, although potentially valuable, are either rejected or used as low grade animal feed or as manure (Table 1).

An important line which has drawn increasing attention during recent years and on which a lot of work is being done in different parts of the world, is the separation of meat from fish waste and small varieties of fish (Kreuzer, 1974; Martin, 1972; Martin, 1974).

Huge quantities of inexpensive varieties of fish are caught as by-catch along with shrimp (Sen and Bhandary, 1972; Menon, 1975). At present these inexpensive varieties of fish are not properly utilized; they are either thrown back in the sea or converted to fish meal or manure.

The quantity of inexpensive varieties of fish will increase considerably with the introduction of larger mechanized fishing boats. Utilization of these fish is an important challenge to fish technologists. This applies equally to many other countries where substantial catches of inexpensive varieties of fish are caught but not utilized because of their high bone content, very small size or lack of taste. FAO (1971) has estimated that an annual potential of 40 million tonnes of underutilized fish could be made available in the form of separated meat for use in a variety of new products.

Table 1

Estimated landings of inexpensive varieties of fish in India
during 1976 (in tonnes)

Fish	Landings
Silver bellies (<i>Leiognathus</i> spp.)	46 996
Ribbon fish (<i>Trichiurus</i> spp.)	68 353
Catfish (<i>Tachysurus</i> spp.)	44 355
<i>Anchoviella</i> spp.	31 215
<i>Thrissocles</i> spp.	18 939
Whitefish (<i>Lactarius</i> spp.)	12 381
<i>Chirocentrus dorab</i>	10 678
Horse mackerel (<i>Caranx</i> spp.)	26 932
Sharks (elasmobranch)	57 449
Non-penaeid prawns	76 812
Sciaenids	89 564
Soles	10 396

MEAT/BONE SEPARATION

The successful production of separated meat will depend to a large extent on the standardization and adoption of a simple method of treatment of the catch, either in the fishing boats or immediately after landing, for long periods even under tropical conditions without undergoing any spoilage. Icing of whole fish in improved bamboo baskets (Fig. 1) and storage of separated meat under frozen condition would be the most convenient line of approach (Anandaswamy and Veeraraju, 1971).

It has been suggested that minced flesh from two or more species of fish might be mixed to adjust texture or flavour. However, it is inadvisable to mix flesh from gadoid fish with that of other species. Such minced flesh suffers a rapid loss of protein solubility during frozen storage due to the formation of dimethylamine and formaldehyde from the trimethylamine oxide of the muscle. The exclusion of gadoid kidney and blood from minced fish preparations is recommended (Dingle and Hines, 1975).

The principle of meat separation is the squeezing and tearing action of a wide flexible belt moving against the outside of a rotating perforated stainless steel drum. The softer and less cohesive flesh is forced through the perforations of the drum by the pressure developed between the drum and the belt rotating in the same direction but at a different speed. Skin and bones remain behind on the belt.

A meat strainer is provided in some machines for the second stage removal of fine bone particle. Some machines use a stationary screen with internal rotating scrapers rather than a rubber belt.

A decrease in screen size (from 0.1575 to 0.0508 cm) has been found to cause a loss in the quality of the myofibrils. The smallest screen size destroyed the characteristic myofibrillar structure causing breaks at the Z or M lines. These effects on the structural composition are likely to play a significant role in the functional properties and stability of mechanically deboned poultry meat. The effect of screen size upon meat quality of the fish flesh is under study.



Fig. 1 — A new bamboo container with a polythene-lined gunnysack as insulation for the transportation of iced fish.

SPECIFICATIONS

The fish are beheaded and eviscerated before passing them through a meat separating machine. However, this process is intensive as most of the inexpensive varieties of fish are of small size.

Great care should be taken to separate poisonous types of fish, if any, from the catch. The materials used should be fit for human consumption. Silica content should be almost negligible and this will require through washing of the fish to remove any adhering sand prior to processing.

Additives such as preservatives, antioxidants, colouring or flavourings could be added as per the appropriate official agency of the country where the separated meat, in frozen condition or processed into products, is to be used.

Specifications for moisture and bone content are essential to exercise proper quality control of the product. The other criteria to be considered are protein content, protein efficiency ratio (PER) and available lysine content to avoid dilution or admixing of other cheaper material.

MICROBIOLOGICAL QUALITY

The mechanically separated meat can have a high total plate count if the fish waste or small varieties of fish are not kept cold or deboned immediately. When strict limitations on time, temperature and storage conditions

are rigorously followed, microbiological quality of mechanically separated meat compares very well with that of hand deboned meat. Also, the mechanically deboned meat has to be chilled immediately to prevent multiplication of viable bacteria; contamination may arise from machinery, manual handling, etc. Minced fish provide an ideal media for the growth of bacteria, and the control of microbiological quality is essential to safeguard the health of the consumer.

The microbiological load in mechanically separated meat is therefore dependent upon such factors as the source of fish and the temperature while the meat is separated, handled and stored.

UTILIZATION OF SEPARATED MEAT IN DIFFERENT PROCESSED PRODUCTS

The Central Food Technological Research Institute has reported on the preparation of fish macaroni (Moorjani *et al.*, 1964); fish wafers (Moorjani, 1970). Separated meat has also recently been utilized for the preparation of a highly delicious baked product and fish briquettes.

BAKED FISH

White sardine (*Kowala coval*), croaker (*Pseudosciaena* sp.), mullet, mixed small carps and silver bellies (*Leiognathus* sp.) were used in these investigations. Minced meat was obtained from thoroughly washed, eviscerated and beheaded fish using a meat/bone separator.

Table 2

Ingredients for the preparation of baked fish from inexpensive varieties of fish

Constituents	Weight (g)
Minced fish meat	1 000
Fat	75
Soji (wheat semolina)	150
Sugar	22.5
Salt	34.5
Onion	15.0
Garlic	8.0
Potassium sorbate	0.6
Ascorbic acid	0.3
Sodium succinate	0.3
Sodium polyphosphate	2.55
Colour (Ponceau)	0.06
<i>Spices</i>	
White pepper	7.5
Ginger	1.5 finely ground
Coriander powder	4.5
Chilli powder	2.75
Cinnamon	1.5

The separated meat and the other ingredients (Table 2) were thoroughly mixed in a bowl chopper with slush ice (about 140g for every 1000 g fish meat). The blend was then placed in pastry-type circular waxed paper in lots of 100 g and baked at 160°C for about 40-60 min. A flow diagram of the process is given in Fig. 2.

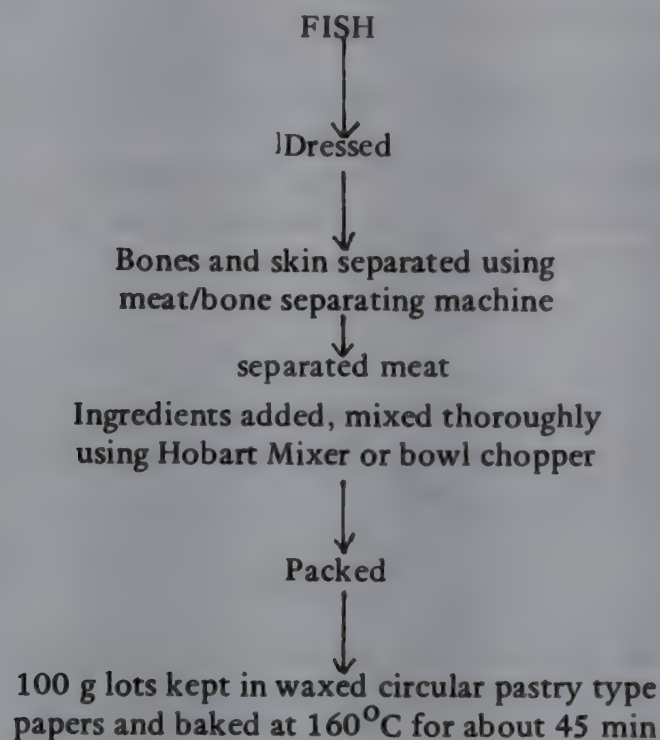


Figure 2. Flow diagram for processing of baked fish from separated meats

Taste panel studies were conducted with six trained personnel to score for flavour and taste. Points were assigned from 10 for an excellent sample to 0 for a very bad one. The bone content was estimated according to the method of Yamamoto and Wong (1974). Six batches of fish cakes, each batch from about 10 kg of fish, were prepared and the results presented are an average of all these trials.

The yield of minced flesh based on round fish was of the order of 37-60 percent while the yield was 63-85 percent based on the dressed weight of fish (Table 3).

Baking at 160°C for 45 min was adequate considering the total plate count, *E. coli* and coagulase-positive staphylococci (Table 4). The finished product has the following average composition: moisture 69 percent, protein 2.6 percent, fat 9.0 percent, ash negligible, carbohydrates (by difference) 9.0 percent. The product was liked very much for its flavour, taste and texture (Table 5). Many other small sized marine and freshwater fish have also been successfully utilized in this way

The bone content of mullet was 2.9 g (dry basis) per 100 g dressed fish. The bone content in the separated meat was only 0.0659 g (dry basis) per 100 g dressed fish. Thus, from small and inexpensive varieties of fish which are used for manure or fishmeal, or often thrown back into the sea, a very delicious product can be prepared. Many such varieties of fish are not popular due to their high content of tiny bones and also due to lack of acceptable flavour.

With the technology as indicated above, a processed product with attractive profiles can be obtained from such fish.

Table 3

Yield of minced flesh from
a meat/bone separator

Fish	Percentage yield of separated meat based upon	
	round weight	dressed weight
Croaker	50	77
White sardines	58	77
Silver bellies	60	85
Mullets	37	63
Miscellaneous carps, small size	50	77

Table 4

Microbiological load of baked fish

Test	(per g)
Total plate count	1 800
<i>E. coli</i>	nil
Coagulase-positive <i>Staphylococcus aureus</i>	nil

FISH BRIQUETTES

Meat picked from silver bellies was minced and mixed with ethanol of 95 percent by volume (meat: alcohol ratio 1:0.5-1.0) containing BHA + propylgallate + citric acid (0.01 + 0.003 + 0.005 percent). The amount of ethanol used could be varied slightly depending on the water-binding capacity of the fish so that maximum fluid loss occurs. After about one hour, the mix was pressed to release fluid and formed into briquettes which were then air dried to about 50 percent moisture. The weight of the briquette is about 12.0 g; diameter 6, cm; and thickness, 0.75 cm. The products have been compared with the briquettes made by a quick salting process (Del Valle *et al.*, 1973; Bligh, 1976) The briquettes are prepared for use by adding water, bringing the mixture to boil and discarding the free fluid.

Experiments to test the shelf-life of the briquettes stored at $36 \pm 1^{\circ}\text{C}$ show that changes in rancidity development coupled with changes in colour and off flavour are much more pronounced in salt-treated fish than in alcohol-treated fish. This is possibly due to easy miscibility of antioxidants, dissolved in ethanol, with fat. Also rancidity is likely to be accelerated due to the catalyzing action of salt.

Table 5

Taste panel score sheet for baked fish

	Fresh	From blend stored for 4 months at -20°C
Texture	8	7.1
Colour	8	7.0
Salt	8	7.9
Flavour	8	7.3
General appearance	8	7.6

Score

Like very much:	10
Like:	7
Dislike:	5
Dislike very much:	0

The separated meat has also been successfully utilized in the preparation of fish 'bonda', fish fingers and cutlets. Fish 'bondas' are made from fresh fish mince or thawed blocks after admixing with other ingredients and condiments. The dough is rolled into a ball shape and deep fried at $160-180^{\circ}\text{C}$ for 5-10 min.

The dressed fish could be subjected to thermal processing on the same principle as the canning of fish. The bones would become softened and the entire material, i.e., bones and skin could be included with the meat in various preparations. With this approach the yield of the material is more than the separated meat from dressed fish.

UTILIZATION OF FISH WASTE

Fish waste, after suitable processing could be utilized for poultry feeding. The waste from shrimp and squilla could be converted into a useful product hitosan, a high M.W. polymer, which finds extensive use in various industries (Moorjani *et al.*, 1975; Moorjani *et al.*, 1977).

The separated meat from inexpensive varieties of fish could be used as it is or after thawing frozen blocks for a number of processed fish products with attractive profiles. Yield of meat, labour costs, hygienic standards to prevent health hazards and the use of certain varieties of fish which are prone to deterioration in frozen storage, are some of the points which have to be considered seriously. Use of cereals mixed with minces for the preparation of low cost fish based foods deserves attention.

CONCLUSION

Many fish of lower market value could be upgraded as acceptable products with attractive profiles through the application of meat/bone separation technology.

REFERENCES

- Anandaswamy, B. and P. Veeraraju, Insulated drip proof transportation of fresh fish with ice. *Packaging, India*, 1971 3(4):p. 11
- Bligh, E.G., Salt minced fish. Halifax, Halifax Laboratory, Canada Fisheries Environment and Market Service 1976
- Del Valle, F.R. *et al.*, Pilot plant production of quick salted fish. *J. Food Sci.*, 38:46 1973
- Dingley, J.R. and J.A. Hines, Protein instability in minced flesh from fillets and frames of several commercial Atlantic fishes during storage at -5°C . *J. Fish. Res. Board Can.*, 32(6):775-83 1975
- Disney, J.G. and R.G. Poulter, Possible approaches to the handling of under-utilized fish species. Paper presented to the 2nd Annual Tropical and Sub-Tropical Fisheries Technological Conference of the Americas (Biloxi) 1977
- Gulland, J.A. (Comp.), The fish resources of the ocean. West Byfleet, Surrey, Fishing News (Books) Ltd., 225 p. Rev.ed. of *FAO Fish. Rep.*, (97):425 p. (1970) 1971
- Kreuzer, R. (Ed.), Fishery products. West Byfleet, Surrey, Fishing News (Books) Ltd., p. 151-3, 156, 295 and 325 1974
- Martin, E.R. (Ed.), Oak Brook Seminar: Mechanical recovery and utilization of fish flesh, September 21-22 1972
- Second technical seminar on mechanical recovery and utilization of fish flesh. Boston, Massachusetts, June 12-13 1974
- Menon, D., Production of picked meat from fresh fish. *Seafood Export J.*, 7:35 1975
- Moorjani, M.N., Processed fish products. Paper presented to the Symposium on protein foods, CFTRI, Mysore 1964
- ,FPC story 12: fish enriched wafers. *Food Technol.*, Champaign, 24, 1378 1970
- Moorjani, M.N. *et al.*, Parameters affecting the viscosity of chitosan from prawn waste. *J. Food Sci. Technol.*, 12(4):187 1975
- ,Chitosan of high viscosity from squilla and protein as a valuable by-product. Paper presented to the First International Symposium on Chitin Chitosan held at Boston, 13-14 April. 1977
- Sen. D.P. and C.S. Bhandary, Utilization of miscellaneous fish in India. *Seafood Export J.*, 4(1):161 1972
- Yamamoto, M. and J. Wong, Simple chemical method for isolating bone fragments in minced fish flesh. *J. Food Sci.* 1974 39:p. 1259

STUDIES ON THE FATTY ACID COMPOSITION OF HILSA OIL

by

H.S. Huq and S.F. Rubbi
Food Science and Technology Division
BCSIR Laboratories
Dacca, Bangladesh

Abstract

With the establishment of a hilsa canning plant at Dacca, it has become necessary to keep hilsa in cold storage for some time. It has been observed that during storage even for a short time, the fish develops a predominantly rancid taint which persists in the canned product.

In order to investigate changes in fat components during frozen storage, a preliminary study has been completed on the fatty acid composition of fresh hilsa oil by argentation chromatography and gas liquid chromatography. The results obtained indicated that the fatty acid chain length of hilsa oil was between C₁₂ to C₂₂ and the degree of unsaturation between 0 to 6 double bonds. The saturated and monounsaturated acids amounted to about 88 percent of the total acids.

The unsaponifiable content and iodine value of the same oil was estimated to be 1.25 and 90 respectively. The total fat content was 18 percent.

INTRODUCTION

The fish fats of marine or freshwater fish contain a large number of fatty acids and their triglycerides are extremely heterogeneous in character (Hilditch and Williams, 1964). The presence of large amounts of polyunsaturated acids of C_{16:4}, C_{18:4}, C_{20:5} and C_{20:6} which have associated with equal amounts of saturated and monounsaturated acids of C_{14:0}, C_{16:0}, C_{16:1}, C_{18:0} and C_{18:1} makes the mixture very complex and studies of their fatty acid composition by conventional methods are very difficult. Moreover, the presence of polyenic acids in fish fats accelerates the rate of autoxidation and, as a result, the fat becomes rancid within a short period (Hilditch and Williams, 1964).

The oil of freshwater fish contains fewer polyenic acids than that of marine fish but the amount of saturated and monounsaturated acids is very high (85-90 percent). In marine fish oils, the polyunsaturated acids are very high (40-50 percent) and are associated with an equal amount of saturated acids (Hilditch and Williams, 1964).

EXPERIMENT

- (a) Raw materials: six hilsa were collected from the local market, minced, dried and the oil extracted by chloroform-methanol mixture (Scorry, 1965).
- (b) The physical and chemical characteristics of the oil were determined by conventional methods.
- (c) The methyl ether of fatty acids of the oil were prepared (Lambertsen, 1972).
- (d) The methyl ether were fractionated by argentation chromatography (De Vries, 1963; Morris, 1966) and total methyl ether were analysed before and after hydrogenation by gas liquid chromatography (James and Martin, 1956; James, 1959), followed by analysis of each fraction obtained with the help of argentation chromatography.
- (e) The methyl ether were hydrogenated and analysed by GLC (Hoque *et al.*, 1973).

RESULTS

Analysis of the total methyl ether of fresh hilsa oil before and after hydrogenation by GLC in two types of column stationary phases (polar and non-polar), followed by the analysis of each fraction obtained after the fractionation with the help of argentation chromatography (column and TLC), permitted the determination of the total fatty acids in hilsa oil as shown in Tables 1 and 2.

Table 1

Fatty acids before hydrogenation by GLC

Fatty acids	Weight (%)	Fatty acids	Weight (%)
C _{12:0}	0.60	C _{18:3}	0.40
C _{14:0}	7.80	C _{18:4}	0.50
C _{15:0}	0.25	C _{20:0}	1.50
C _{16:0}	31.80	C _{20:1}	0.80
C _{16:1}	12.20	C _{20:2}	0.07
C _{16:2}	0.90	C _{20:3}	0.40
C _{16:3}	1.30	C _{20:4}	0.46
C _{18:0}	8.10	C _{20:5}	5.70
C _{18:1}	25.54	C _{22:5}	0.60
C _{18:2}	0.50	C _{22:6}	0.38

Table 2

Fatty acids after hydrogenation

Fatty acids	Polar phase	Non-polar phase
	Weight (%)	Weight (%)
C _{12:0}	0.70	0.60
C _{14:0}	7.80	7.70
C _{15:0}	0.20	0.20
C _{16:0}	46.30	46.40
C _{18:0}	35.00	34.90
C _{20:0}	8.80	8.90
C _{22:0}	1.20	1.30

A comparative study on the fatty acid composition of the fresh and canned hilsa oil after one year showed no significant changes on the fatty acid composition (Table 3).

Table 3

Fatty acids of fresh and canned hilsa oil

Fatty acids	Fresh oil	Canned oil	Fatty acids	Fresh oil	Canned oil
12:0	0.60	0.50	18:3	0.40	0.80
14:0	7.80	7.40	18:4	0.50	0.70
15:0	0.25	0.40	20:0	1.50	1.30
16:0	31.80	31.00	20:1	0.80	0.70
16:1	12.20	11.00	20:2	0.07	0.10
16:2	0.90	1.40	20:3	0.40	0.40
16:3	1.30	2.50	20:4	0.40	0.40
18:0	8.10	7.10	20:5	5.10	6.50
18:1	25.54	23.30	22:5	0.80	0.80
18:2	0.50	1.30	22:6	0.38	0.50

DISCUSSION

The physical and chemical characteristics of the hilsa oil were within normal limits. Five fractions were obtained by argentation chromatography (column and preparative TLC) (De Vries, 1963; Morris, 1966). The analysis of each fraction by GLC was corroborated with the analysis of total methyl ether before and after hydrogenation by gas liquid chromatography (James and Martin, 1956; James, 1959).

The changes in the fatty acid composition in canned fish showed some minor alteration in the fat component. This difference may be due to batch and seasonal variation.

SATURATED ACIDS

The saturated acids made up about 50 percent of the total acids. The acids of chain length of C_{14:0}, C_{16:0} and C_{18:0} were the major acids and those of C_{12:0}, C_{15:0} and C_{20:0} were minor acids. In this regard, freshwater hilsa oil from Bangladesh corresponded with Group IV according to the classification of Tsujimoto (1932) where the unsaponifiable content was lower than 2 percent and there was an exceptionally high proportion of saturated acids (up to 50 percent). These characteristics are not generally found in common marine fish fats (Hilditch and Williams, 1964).

Monoenic acids

The monoenic acids made up about 38 percent of the total acids. The palmitoleic acid and oleic acid were the two significant monoenic acids. The distribution of monoenic acids in hilsa oil also differed from that of marine fish fats where the amount of these two acids was not so prominent (Hilditch and Williams, 1964).

Dienic and trienic acids

In the present study the dienic and trienic acids were of minor importance. In this respect the hilsa fish oil is similar to other marine fish fats (Hilditch and Williams, 1964; Tsujimoto, 1932; Gedam *et al.*, 1971; Graille *et al.*, 1975; Huq *et al.*, 1977).

Polyenic acids

The polyenic acids were significantly lower in hilsa oil in comparison with other fish fats. Among the C²⁰ and C²² series, C_{20:5} was the major acid and others were of minor importance (Table 1), whereas the acids of these two series are highly polyunsaturated and prominent ranging from 4 to 6 double bonds and frequently associated with the acids of C_{16:4} and C_{18:4} (Hilditch and Williams, 1964; Tsujimoto, 1932; Gedam *et al.*, 1971; Graille *et al.*, 1975; Huq *et al.*, 1977).

Odd and iso-acids

Only one odd carbon number acid (C_{15:0}) was found in hilsa oil; no iso-acid was observed. These types of minor acids have been reported in fish oils (Hilditch and Williams, 1964; Graille *et al.*, 1975).

CONCLUSION

The fatty acid composition and the general characteristics of hilsa oil were studied to find out the nature of unsaturation and the chain length. The investigation revealed that the saturated and monounsaturated acids amounted to about 88 percent of the total acids and 7.8 polyenic acids. The dienic and trienic acids were insignificant. The unsaturation varied from 0 to 6 double bonds and the chain length from C₁₂ to C₂₂.

The present study is being extended to investigate (a) the seasonal variation in the fat component and (b) changes in the oil during frozen storage (glazed and unglazed) of these fish to find out (i) the nature of oxidation or autoxidation (ii), the best possible conditions to improve the quality of fish during frozen storage. The work will be extended further to investigate the composition of the unsaponifiable matter.

REFERENCES

- De Vries, B., Separation of triglycerides by column chromatography on silica impregnated with silver nitrate.
1963 *J. Am. Oil Chem. Soc.*, 49:184
- Gedam, P.H., M.R. Subbaram and J.S. Agarwal, Consecutive chromatographic techniques in the component fatty
1971 acid analysis of sardine oil. *Fette Sefen Anstrichmitt.*, 73:748
- Graille, J., M.S. Huq and M. Nandet, Etude d'une huile de Sardines du Maroc. *Rev. Fr. Corps Gras*, 23:151
1975
- Hilditch, T.P. and P.N. Williams, The chemical constitution of natural fats. London, Chapman and Hall, pp. 10,
1964 32-48 4th ed.
- Hoque, M., A. Ghose and J. Dutta, Use of argentation column chromatography in the identification of fish oil
1973 fatty acids by GLC: application to cod liver oil. *J. Am. Oil Chem. Soc.*, 50:29

- Huq, M.S., M.S. Khan and S.F. Rubbi, Determination of chain length and the degrees of unsaturation of fatty acid composition of Hilsa fish oil by argentation chromatography and gas liquid chromatography. *Bangladesh J.Sci.Ind.Res.*, vol. for 1977 (in press)
- James, A.T., Determination of the degree of unsaturation of long chain fatty acids by gas-liquid chromatography, 1959 *J.Chromatogr.*, 2:552
- James, A.T. and A.J.P. Martin, Analysis of fatty acids by gas-liquid chromatography. *J.Appl.Chem.*, 6:105 1956
- Lambertsen, G., Lipids in fish fillet and liver; a comparison of fatty acid composition. *Fiskeridir. Skr.(Teknol. Unders.)*, 5(6):15 p. 1972
- Morris, L.J., Separations of lipids by silver ion chromatography. *J.Lipid Res.*, 7:717 1966
- Scorry, N.M., Lipids analysis. New York, Interscience Publishers Inc., vol. 11:60-100 1965
- Tsujimoto, M., Liver oils of elasmobranch fish. *J.Soc.Chem.Ind.Jap.*, 51:317T 1932

MINCED FISH TECHNOLOGY AND ITS POTENTIAL FOR DEVELOPING COUNTRIES

by

J.J. Matsumoto
Department of Chemistry
Sophia University
Tokyo, Japan

Abstract

Since the development of 'frozen mince' (reito surimi) from Alaska pollack in 1959, there has been a remarkable increase in the catch of this North Pacific fish, resulting in a supply of three million tonnes of fish per year to the Japanese market. The frozen mince technique is based on the prevention of denaturation, during freezing, of the fish actomyosin by the removal of albumins and inorganic salts and by the addition of sucrose and polyphosphates.

Based on a fundamental study of frozen fish mince, the author and his colleagues have proposed some twenty new cryoprotective additive compounds, among which glutamate and aspartate have the greatest effect. These compounds can also modify the eating quality of cooked products.

These results, together with the technical success of fish mince and a proposal for another new technique, illustrate the potential for products developed from fish mince in many areas of the world.

INTRODUCTION

The success of the frozen surimi (frozen mince or reito surimi) industry in Japan presents an example of the successful development of an unutilized food resource by introducing an original technique.

This paper deals with a profile of the frozen surimi industry, its scientific background and an analysis of the conditions which were instrumental to success.

FROZEN SURIMI INDUSTRY

History

In spite of the continuous demand for fish and of the intense fishing activity in Japan, the Alaska pollack, *Theragra chalcogramma*, caught in the northern waters of this country, was not attractive to the fishermen until 1960 because the fish had little commercial value. Alaska pollack meat was not only unpalatable but was also a poor material for processing into any kind of conventional food. It was used for dried fish or fishmeal. The meat could not be processed into kamaboko (a popular Japanese fish jelly), when it was ice-stored for more than 2 days after capture. Conventional frozen storage also damages the processing quality.

In 1959, a new technique was proposed by a group of scientists headed by K. Nishiya (Nishiya *et al.* 1959, 1961; Nishiya, 1963). With this technique, the problems of frozen storage of the susceptible Alaska pollack meat were overcome and the product, frozen surimi, could be processed successfully into a kamaboko jelly which has excellent jelly strength and eating equalities. This success stimulated the market and the catch of Alaska pollack increased annually.

Until that time, the kamaboko industry had suffered a shortage of raw material in spite of the increasing demand by the consumers; the supply of the new material was, therefore, welcomed by kamaboko manufacturers.

The major concerns in the fishing industry took up the challenge in developing the North Pacific resources, dispatched their factory ships with on-board frozen surimi plants and, until 1976, brought back every year 1 million tonnes of fish. They are now subject to a limit imposed by the coastal countries.

From Table 1 it is seen that the increase in the catch and in kamaboko production is apparently triggered by the growth in the production of frozen surimi. In 1973, the total catch was 3 million tonnes and production of frozen surimi was 380 000 tonnes. This indicates that an extra 100 000 tonnes of animal protein was added to the Japanese food basket; it represented 900 g protein *per caput* per year or 2.4 g protein *per caput* per day. The introduction of this new technique has provided a means of utilizing a huge marine resource, which nobody had cared about previously, as a food for the people and has also resulted in a great deal of profit and income to the people engaged in Alaska pollack fishing and kamaboko processing. Sales of frozen surimi in 1973 are estimated to be as high as Yen 100 billion (U.S.\$ 400 million).

Table 1

Catch of Alaska pollack and production of frozen surimi and kamabokos (thousands of tonnes)

Year	Alaska pollack	Frozen surimi	Kamabokos	Note
1955	231		306.7	
1956	235		369.6	
1957	281		434.4	
1958	279		436.6	
1959	343		476.3	Proposal of frozen surimi
1960	354	0.25	509.4	
1961	390	2.5	573.4	
1962	452	4.5	649.6	
1963	531	9.3	688.1	Patent registered
1964	683	18.1	734.6	
1965	690	31.8	797.2	Beginning of on-board production
1966	774	43.0	895.1	
1967	1 247	84.1	912.0	
1968	1 606	144.6	999.4	
1969	1 944	196.4	1 077.2	
1970	2 347	261.3	1 081.3	
1971	2 707	324.0)	1 127.1	
1972	3 035	359.0) a/	1 156.2	
1973	3 021	381.0)	1 185.1	
1974	2 856	384.0	1 148.7	
1975	2 677	360.8	1 155.0	

Statistics of Ministry of Agriculture and Forestry, Japan

a/ Estimated figure

Description of the technique

The process for preparing frozen surimi is illustrated in Table 2. The whole process is simple and the additives used are all popular and harmless.

For processing into kamabokos, the frozen surimi is thawed and 2 to 4 percent common salt added with some taste improvers. It is ground or minced, cast into pieces and then heated, resulting in an elastic jelly. If the proteins in the raw material are denatured in freezing, an elastic, smooth jelly is not produced. With the above method the proteins are, however, well preserved from denaturation. For as long as one year in cold storage below -20°C , they give kamaboko jellies with excellent quality

Table 2

Major processes of frozen Surimi technique

Operation	Equipment
1. Dressing	None (manual)
2. Removal of skin and bones	)
3. Mincing of meat	) Deboning machine
4. Washing of meat with water (2-3 times)	Washing tank and revolving sieve 1/. 4/
5. Removal of connective tissues	Revolving press sieve
6. Reduction and adjustment of moisture content	Revolving press squeezer ^{4/}
7. Addition of stabilizer ^{2/} 10 percent sucrose +0.2-0.5 percent polyphosphate	Mixing tank
8. Packing	Packer ^{3/}
9. Freezing and frozen storage	Freezer (either shelf or contact plate)

1/ Three sets of a washing tank and a revolving sieve are lined up in successive series

2/ Ten percent sucrose may be substituted by either five percent sucrose plus five percent sorbitol or ten percent sorbitol

3/ The mince (surimi) is rolled out into a 10 kg flat block and wrapped with film

4/ The revolving sieve and the revolving press squeezer are machines originally designed for improvement of the frozen surimi technique

Scientific background of frozen surimi

The studies of many research workers, including Nishiya's group, have resulted in the successful prevention of the freeze denaturation of fish proteins in frozen surimi. This success has been attributed to the following three effects:

- (a) Removal of inorganic salts from the fish muscle
- (b) Removal of albumins or water-soluble proteins
- (c) Preventive effect of the additive compounds on the freeze denaturation of the fish muscle proteins (actomyosin).

Experimental analyses of the processes have proved that the washing process (Table 2) is responsible for the first and the second affects (Takada, 1971; Okada, 1964); the third effect is due to the added sucrose, sorbitol and polyphosphates (Tamoto *et al.*, 1961; Arai, 1971).

Extensive studies (Noguchi and Matsumoto, 1970, 1971, 1975 a, b, c, 1976; Matsumoto, 1971) have shown that the preventive effect on the freeze denaturation of the fish muscle proteins is not only caused by sucrose, sorbitol and polyphosphates, but is related to a number of Biochemical compounds. Compounds including amino acids, hydroxylic acids, dicarboxylic acids, pentoses, hexoses, disaccharides, oligosaccharides and polyalcohols were effective in preventing freeze denaturation. The most effective among those tested was Na-glutamate which was effective at a concentration as low as 0.025 mol/l (0.38 percent of meat).

Physico-chemical studies on parameters, such as solubility, salting-out behavior, viscosity, ultra-centrifugal behaviour and electrophoretic properties have proved that the fish actomyosin was preserved in its native state, when stored frozen with the protective additives. The same effect was shown on the biochemical properties such as ATPase activity, and superprecipitation capacity. Food technological tests on processed kamaboko jellies made from fish mince, stored frozen with Na-glutamate and other additives, were successful. The prevention of freeze denaturation was also proved by electron microscopic studies (Tsuchiya *et al.*, 1975; Oguni *et al.*, 1975).

These results have shown that the frozen surimi technique, which had been based upon the incidental findings of the inventors, is in accordance with current scientific thinking. The results also provide scope for extending the technique to the use of other varieties of fish and to the use of a wider variety of additive compounds, many of which are found in natural living bodies. In addition to preventing freeze denaturation, some of the additives are of use in improving the eating quality of the product, for example, Na-glutamate accelerates the jelly formation of proteins (Noguchi and Matsumoto, 1970).

ANALYSIS OF COMMERCIAL SUCCESS

The conditions which favoured the commercial success of this novel technique can be listed as follows:

- (a) Potential market demand. When frozen surimi appeared in the market, the kamaboko industry lacked plentiful supplies of raw material due to the decline of fishing in the East China Sea.
- (b) Abundant undeveloped natural resources. In spite of the large size of the stock, Alaska pollack had not been fished efficiently because of its poor quality.
- (c) Excellent quality of the new product. Thanks to scientific research, the poor quality of Alaska pollack flesh was given an excellent commercial value by the frozen surimi treatment.
- (d) Simplicity of the technique. The technique was simple and safe and did not need any vigorous treatment or dangerous chemicals. Consequently, the equipment was comparatively inexpensive and the technique was extended with little difficulty.
- (e) Technical potentiality of food engineering. The frozen surimi industry was aided by equipment improvements, which relied on a favourable technological base in Japan.
- (f) Drive and determination of people in Government and industry. This has encouraged investment and the organization of the industry.

These conditions, except possibly item (e), can be found in any part of the world. Equipment can be imported and if capital investment is lacking it may be made available through international cooperation. The essential ingredient is the will of the local technologists. The success of the Japanese frozen surimi industry suggests that there is considerable scope in developing countries for introducing novel fish products.

REFERENCES

- Arai, K., Denaturation of muscle proteins at low temperatures. *New Food Ind.*, 13(12):48-55
1971
- Matsumoto, J.J., Control of the freezing-denaturation by chemical substances. *Proc.Int.Congr.Refrig.*, 13(3):
1971 237-41
- Nishiya, K., Manufacture of frozen surimi. Japan Patent No. 306857
1963
- Nishiya, K. *et al.*, Studies on freezing of surimi (fish paste) 3. *Mon.Rep.Hokkaido Munic.Fish.Lab.*, 17(9)
1959
- , Studies of freezing of Surimi (fish paste) 5. *Mon.Rep.Hokkaido Munic.Fish.Lab.*, 19(4)
1961
- Noguchi, S. and J.J. Matsumoto, Studies on control of denaturation of fish muscle proteins during frozen storage
1970 1. *Bull.Jap.Sci.Fish.*, 36(10):1078-87
- Noguchi, S. and J.J. Matsumoto, Studies on control of denaturation of fish muscle proteins during frozen storage
1971 2. *Bull.Jap.Soc.Sci.Fish.*, 37(11):1115-22
- , Studies on control of denaturation of fish muscle proteins during frozen storate 3.
1975a *Bull. Jap.Soc.Sci.Fish.* 41 (2) 243-9
- , Studies on control of denaturation of fish muscle proteins during frozen storage 4. *Bull.Jap.Soc.Sci.Fish.*,
1975b 41 (3):329-35
- , Studies on control of denaturation of fish muscle proteins during frozen storage 5. *Bull.Jap.Soc.Sci.Fish.*,
1975c 41 (7):779-86
- , Studies on control of denaturation of fish muscle proteins during frozen storage 6. *Bull.Jap.Soc.Sci.Fish.*,
1976 42(1):77-88
- Oguni M., T. Kubo and J.J. Matsumoto, Studies on denaturation of fish muscle proteins. *Bull.Jap.Soc.Sci.Fish.*,
1975 41(11):1113-23
- Okada, M., Effect of washing on the jelly forming ability of fish meat. *Bull.Jap.Soc.Sci.Fish.*, 30(2):225-61
1964
- Takeda, F., Technological history of frozen surimi industry. *New Food Ind.*, 13(12):27-33
1971
- Tamoto, K. *et al.*, Studies of freezing of surimi (fish paste). *Rep.Hokkaido Fish.Exp.Lab.*, (23):50 p.
1961
- Tsuchiya, T. *et al.*, Preservation of freeze denaturation of carp actomyosin by sodium glutamate. *J. Biochem.*, 77
1975 (4): 853-62

THE CANNING OF INDIAN PELAGIC FISH IN A YUGOSLAVIAN CANNING PLANT

by

V. Perovic
UNDP/FAO Pelagic Fishery Project
Cochin, India

and

G.E. Samuel
Integrated Fisheries Project
Cochin, India

Abstract

Experiments in canning Indian fish in a Yugoslavian canning plant were made in June, 1977. The purpose was to determine if modern continuous lines, developed for canning Mediterranean types of fish, are suitable for Indian species.

Four different types of fish were used: oil sardine (*Sardinella longiceps*), Indian mackerel (*Rastrelliger kanagurta*), little tuna (*Euthynnus affinis*) and whitebait (*Stolephorus* spp.). Eleven different products were packed in three different types of steel and aluminium containers.

The results were promising. With small changes in the canning lines and in the technological processes it will be possible to produce canned fish of standards acceptable in the world markets.

INTRODUCTION

Although Indian waters are reasonably rich with fish suitable for canning, particularly along the southwest coast of Goa, Karnataka, Kerala and Tamilnadu States, the fish canning industry is not well developed.

As there is likely to be a new trend in the development of the fishing industry in India, namely the proposed introduction of large size fishing vessels, the Pelagic Fishery Project organized an experiment for canning Indian fish in a modern canning plant at Kombinatski Zavod Ulov, Preradnja i Promet Ribom 'Adria', in Zadar, Yugoslavia. The experiment was organized in close cooperation with the Integrated Fisheries Project and the Marine Products Export Development Authority, both of Cochin, India and the Prehrambeno-Technoloski Institut, Zagreb, Centar Za Ribarstvo Mediterana at Zadar, Yugoslavia.

This paper reviews these experiments and includes some data about the availability of raw material in Indian waters, the existing status of the fish canning industry in India and a short description of the activities of 'Adria'. Details of technological processes and packaging materials are included.

RAW MATERIAL AVAILABILITY

The most important fish suitable for canning in India are pelagic fish such as sardine, mackerel and tuna. Prawns and other crustaceans are presently canned in India but production is limited.

Sardine

There are several types of sardines available in Indian waters. Among them the oil sardine (*Sardinella longiceps*) is by far the most abundant (UNDP/FAO, PFP Progress Report No. 18); it has excellent qualities for canning and is without doubt the most important fish for canning. The average annual stock of oil sardine for the

period 1960-71 has been estimated at 400 000 tonnes in the present fishing grounds (Silas *et al.*, 1976). There are various opinions, from industrial and research sources, that 50 000 tonnes of oil sardine per year could be available for canning purposes in the area between Goa and Cochin.

Mackerel

Indian mackerel (*Rastrelliger kanagurta*) is available in large quantities in Goa, Karnataka and Kerala coastal areas. The standing stock has been estimated at 57 000 tonnes for the period 1960-71 (Silas *et al.*, 1976) but the trend in the catch shows erratic annual fluctuations which are characteristic for most pelagic species along the west coast of India.

Whitebait

The extent of the whitebait (*Stolephorus* spp., previously called *Anchoviella*) resource is not fully known and estimates are sometimes contradictory. According to the UNDP/FAO, PFP Progress Report No. 18, in the year 1973, the stock of whitebait was largest in June/July and was estimated to be about 500 000 tonnes. Surveys in August and October, 1974 indicated 780 000 and 810 000 tonnes respectively. The situation in 1976 and the beginning of 1977 was quite different with whitebait present only in limited quantities (personal communication, Master fishermen H. Klok and N. Hellevang). Thus there appear to be large fluctuations in the annual stock of whitebait. The largest landings and heaviest fishing occur in the Gulf of Mannar from July to October; it is thought that 200 000 tonnes of whitebait could be landed for industrial purposes (personal communication, K.V. Narayan Rao).

Tuna

There are indications that the larger pelagic species (tunas and tuna-like fishes) in the waters around Lakshadweep, Maldivian Archipelago, Andaman and Nicobar Islands are much larger than indicated by catch records. A few thousand tonnes of skipjack (*Katsuwonus pelamis*) are harvested in Lakshadweep and the Maldivian Archipelago (Silas *et al.*, 1976). Skipjack and little tuna (*Euthynnus affinis*) are also present in the coastal area of the west coast. As the tuna fishery is not yet developed in India, tuna canning could become an important part of the Indian fishing industry.

EXISTING FISH CANNING INDUSTRY IN INDIA

Canning is a relatively new method of fish processing in India. Canning started in the early 1950s when an abundance of shrimp was discovered on the west coast and reached peak production in the early 1970s. During this period, many small canning plants were in operation. Kerala alone had 42 canning plants with a daily capacity of 693 000 round cans of 210 g each. The industry was completely oriented to can shrimp for export and, when frozen shrimp overtook canned shrimp in the world market, the canning industry collapsed.

According to our knowledge, only six fish canning plants are in operation today in Goa, Karnataka, Kerala and Tamilnadu. The technology and equipment in the existing factories is very old and out-dated and canning operations are based mainly on manual work with discontinuous processing.

Realizing the above shortcomings, government organizations and private industry wished to develop a canning industry using Indian fish, packaging and other materials but with modern technology and equipment. Development would begin with the canning of sardine and mackerel, which are available in sufficient quantities, and be followed by whitebait and tuna.

CANNING EXPERIMENTS

Purpose of experiments

Modern, continuous canning lines are sometimes designed for only one type of fish. A canning line for sprats (*Sprattus sprattus*) in Norway has equipment such grading, nobbing and head-cutting machines developed only for sprats. Canning lines developed in Mediterranean areas for sardine (*Sardina pilchardus*), known as the 'Mediterranean sardine line' (Perovic, 1977), have special machinery for nobbing, brining and precooking sardine, a fish which is somewhat similar to the Indian oil sardine (*Sardinella longiceps*). Likewise, specially designed processing equipment is necessary for other fish such as mackerel and whitebait. The machines must be designed and constructed for each type of fish depending on body dimensions and other physical properties.

The idea of conducting a canning experiment in Yugoslavia with Indian fish emerged when technology and equipment for the development of an Indian fish canning industry was discussed. The cheapest solution was to use an existing line, constructed for a similar fish, to establish its suitability for the Indian species. Kombinat Za Ulov, Prerad u Promet Ribom 'Adria', Zadar, in Yugoslavia was chosen since Yugoslavia has a well-known fish canning industry and 'Adria' has several canning lines suitable for canning sardines, mackerel, tuna and other types of fishes by continuous and discontinuous processes. The experiment was carried out with the help and supervision of the Centre for Fish and Economy of Mediterranean (CFEM) and the Zadar branch office of the Food Technology and Science Institute (FTSI), Zagreb.

Raw material

The four most important Indian pelagic fish were used. Two of them, namely tuna and *Stolephorus*, were available in very small quantities since the landing of these fish was poor during the preparation stage of the experiment.

The type of fish and the quantity used in the experiment are given below and a chemical analysis is given in appendix 1.

	<i>k g</i>
Sardine (<i>Sardinella longiceps</i>)	1 854
Mackerel (<i>Rastrelliger kanagurta</i>)	234
Little tuna (<i>Euthynnus affinis</i>)	32
Whitebait (<i>Stolephorus spp.</i>)	20
Total	2 140

As the handling of each type of fish before canning was different, a short description of the treatment given to fish after catching is described below.

Sardine

The sardine were caught and landed by purse-seiners NORIND-2, KALAVA-2 and M-13 (17.4, 13.1 and 9.7 m respectively) of the Integrated Fisheries Project, Cochin, during their daily fishing operations. The fish were caught in the forenoon from the waters off Cochin landed the same day and freezing was completed in the evening. The entire quantity of sardine was frozen between 19 February and 7 March, 1977.

No icing of fish was done on board the vessel. Only very good quality sardines free from defects and damage were selected for freezing. Total length of sardines was in the range of 158-172 mm. Immediately on landing, the sardines were washed thoroughly in chilled water (fresh water and crushed ice) in washing tanks, stowed in aluminium fish boxes and transported to the processing hall. Processing started immediately and the fish were

washed once again with chilled water and weigh in 6 kg units with 10 percent extra weight. The sardines were arranged regularly, a polyethylene lining was used and sufficient chilled water was added to each slab to glaze the fish completely in order to avoid dehydration and rancidity during subsequent frozen storage.

A contact plate freezer was used for freezing. The size of the sardine block was 48.5 x 29.0 cm and the time taken for freezing was two and a half hours. Three frozen blocks of sardines were packed in each master carton (3 x 6 kg = 18 kg net weight) and kept in frozen storage at a temperature between -20°C and -23°C .

Although the quality of the fresh sardine used for freezing was excellent, the quality of the frozen sardine, when used for the canning experiments, had deteriorated due to fluctuations in temperature during transport and storage over a period of 4 months, but was definitely still good and quite suitable for canning.

Mackerel

The entire quantity of mackerel was caught by NORIND-2 and frozen on 8 March 1977. The quality was excellent since the fish were landed within 2 hours of catching. The procedure adopted for freezing, packing, etc., was exactly the same as described for sardines. The size of mackerel used for the experiment (186-199 mm total length) was slightly smaller than that normally caught in commercial fishing operations.

Little tuna

Tuna were caught by the purse-seiner SAMUDRADEVI and landed on 7 April 1977. Quality of the fresh tuna was very good and each fish weighed 3-4 kg. The tuna was frozen in a tunnel freezer at a temperature of -30°C . After freezing, the tuna were glazed in chilled water, packed in master cartons and kept in frozen storage.

Whitebait

Two sizes of whitebait, large (total length 113-133 mm) and small (total length 59-83 mm), were used for the experiment. Large fish were caught by the vessel TUNA during her trawling operation and kept in ice for about 3 days and landed on 12 April 1977. Small whitebait were caught by the research vessel RASTRELLIGER and frozen aboard the vessel. On landing, the whitebait were thawed and refrozen.

The fish were washed thoroughly in chilled water, weighed in 2 kg units with 10 percent extra weight and arranged regularly in waxed duplex cartons with a polyethylene lining. Chilled water was added for glazing. Fish blocks of size 30 x 17.5 cm were frozen in two hours in a contact plate freezer.

Transport

The frozen sardine, mackerel and tuna were transported from Cochin to Madras (600 km distance) on an open truck in a refrigerated container designed to maintain the temperature at -18°C . During the transportation, the temperature in the refrigerated container rose to -5°C on one occasion, due to a defect in the refrigeration system but the defect was rectified and the temperature brought down to -18°C shortly afterwards. The frozen fish were loaded in the refrigerated space of the cargo ship S/S BAKAR, where a temperature of -20°C was maintained, and transported to Rijeka, Yugoslavia. From Rijeka to Zadar, the frozen fish were transported by a refrigerated truck holding a temperature of -18°C .

The frozen whitebait were carried by the authors as hand baggage from Cochin to Zadar. The fish were packed in a plywood box, lined on all sides with 5 in (12.7 cm) polystyrene insulation. The fish were kept in frozen storage at Bombay, Rome and Zagreb where there were delays in the journey. On reaching Zadar, the whitebait were still hard frozen. The quality of the large whitebait was moderately good but the small fish were of poor quality because of thawing and refreezing.

Technological process

The different technological processes used in the experiment are described in general and are also shown by flow sheets.

Sardines

The process used is shown in Flow Sheet 1. After removing from the cartons, the frozen sardine blocks were placed in fish boxes and thawed by a spray of sea water.

A 'Baader 461' nobbing machine was used initially but, when it was found that more than 20 percent of the fish was not properly eviscerated, nobbing was carried out by hand. As the 'Baader 461' machine was adjusted for nobbing *Sardina pilchardus* and was in regular use, it was not adjusted for *Sardinella longiceps*. It was thought that some changes in the machine could be made in order to nob and eviscerate *Sardinella longiceps* properly. After nobbing, the bodies were transported by conveyor to the washing machine and then to the brining unit. Brining time was 20 minutes and the concentration of brine 24°Be. The fish were then washed in another conveyor. A third conveyor transported the fish to the packing table where sardines were packed in 1/4 club 'decollage' cans or in 1/4 dingley aluminium cans. The cans plus fish were transported to the continuous cooker, known under the trade name of 'Utor'. Precooking was divided into two operations: steaming and combined drying and baking. Steaming was carried out at a temperature of 90°C with open steam for 20 minutes. Drying and baking were done at 120°C for 10 minutes using a mixture of steam and hot air. Precooked cans were filled with soybean oil by an automatic filling machine and closed by an automatic seaming machine. A similar operation was used for cans filled with tomato sauce. After washing with hot water in a continuous washing machine, the cans were placed in baskets and sterilized at 115°C for a period of 45 minutes. Sterilization was carried out in hot water with over pressure of 2.5 kp/cm².

After sterilization, the cans were again transported to the washing and drying machine and washed with water and detergent before drying by hot air. The cans were then packed in master cartons. Next day, the canned sardines were inspected, transported and stored in the premises of CFEM, Zadar. The heads and viscera, which represent about 28 percent of the total weight of sardines, went to the fishmeal and oil plant together with offal from other processing lines in 'Adria'.

Mackerel

The handling and thawing operation was the same as for sardines (Flow Sheet 2).

Thawed mackerel were placed on trays and precooked at 100°C for a period of 30 minutes in a steam chamber. Cooked fish was cooled for about 30 minutes at room temperature. Skin, heads, guts, bones, etc., were removed from the meat and fillets were formed by knife. The smaller pieces of meat were packed as flakes. The fillets were packed in 1/4 club 'decollage' cans or in 1/4 dingley aluminium cans; flakes were packed only in 1/4 club 'decollage' cans. The cans were filled with refined soybean oil.

Seaming, sterilization and all other operations were the same as in the processing of canned sardines.

Little tuna

Although only a small quantity of tuna was available (32 kg), normal canning procedures were employed (Flow Sheet 3) but hand packing techniques in 1/4 club 'decollage' cans were used.

The tuna were thawed at room temperature overnight and in the morning were sprayed with sea water. Thawed fish were placed on trays and precooked in steam for 2 hours and 15 minutes at a temperature of 100°C, cooling was at room temperature for 1 hour. During the cleaning operations, heads, guts, skin, bones and

FLOW SHEET 1

Technological Scheme for Sardine Canning

Auxiliary supply

Stages of the process

Residue

PRETREATMENT

Transporting fish from cold
store to canning plant

Removing from cartons

used cartons

Sea water

Thawing by spray of sea water

waste water

Water

Nobbing by hand

(heads, guts, tails,
(waste water

Water

Washing

waste water

Salt + water = brine

Brining

used brine

Water

Washing

waste water

Empty cans

PACKING

damaged fish

Steam, air

PRECOOKING

(condensed water,
(fish drip, hot air

FILLING AND SEAMING

Steam, oil or sauce

Filling with oil or sauce

(condensed water, oil
(purification

Lids → coding

Seaming

oil → purification

Steam, water

Washing of cans

waste water

STERILIZATION

Basket loading

Steam, water

Sterilization in water
with over pressure

waste water

Basket discharging

FINAL OPERATION

Steam, water, air,)
detergent)

Washing and drying of cans

waste water, hot air

Cartons

Packing in cartons

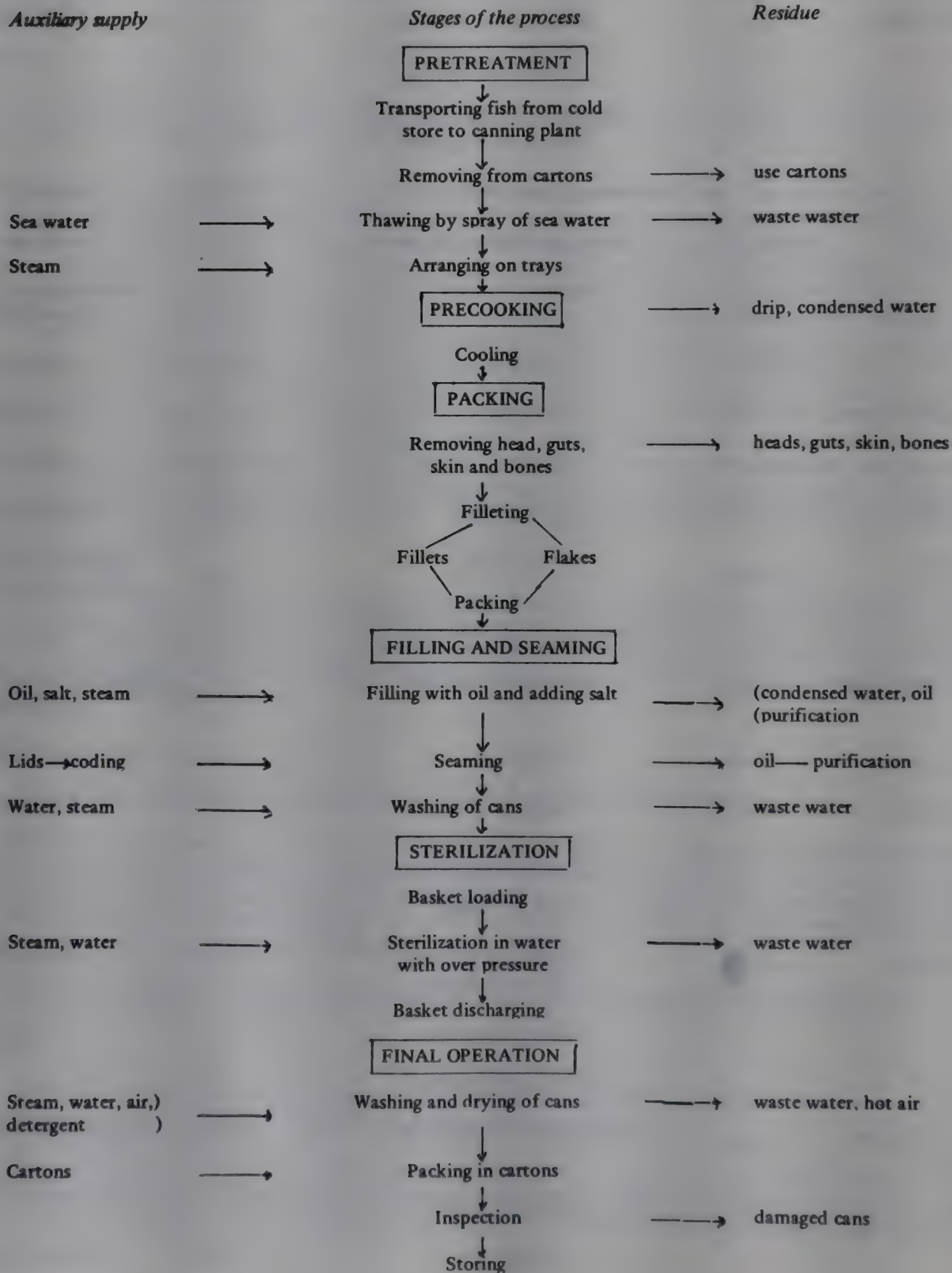
Inspection

damaged cans

Storing

FLOW SHEET 2

Technological Scheme for Mackerel Canning



black (dark) meat were removed. The cleaned meat was cut into flat pieces called fillets and smaller pieces of meat were packed as flakes. The fillets and flakes were packed in 1/4 club 'decollage' cans; oil and salt were added into the cans before seaming. Nine 1/4 dingley aluminium cans were packed with flakes, vegetable and tomato sauce.

All other canning operations were the same as in processing of canned sardines.

Fish spread

The experiments in canning fish spread using *Sardinella longiceps* and *Stolephorus* spp. were carried out in the technological laboratory of CFEM which has developed the technology for the production of canned fish spread (Flow Sheet 4).

The sardine were transported to the laboratory in frozen condition and thawed in running water. Heads and viscera were removed by hand. The edible portion of the fish was washed, placed in a double jacket tilting kettle and cooked with water, fat and salt for 15 minutes. After cooking, the fish and liquid were passed into a cutter where additives such as garlic, tomato concentrate, sodium caseinate and spices were added. The duration of cutting was 15 minutes. After cutting, the paste was packed into number 1/10 round 80 g aluminium cans and seamed by a semi-automatic machine using tear-off lids. Sterilization was effected in water at 115-116°C for 30 minutes with an over pressure of 1.5 kp/cm². The cans were then washed in hot water and detergent, dried and packed in master cartons. The cans were inspected the next day before being stored.

The procedure was the same for the canning of whitebait spread except that the heads and viscera were not removed; after thawing and washing, the frozen round whitebait were directly used for cooking.

Sardine and whitebait were processed into fish spread according to the following recipe:

<i>Ingredient</i>	<i>Sardine spread</i> (%)	<i>Whitebait spread</i> (%)
Fish	48.18	53.57
Water	22.00	13.29
Fat	23.29	26.79
Sodium caseinate	1.92	2.23
Salt	0.95	1.03
Tomato concentrate (30%)	1.68	1.88
Garlic (powder)	0.72	0.80
Spices	0.60	0.45
	100.00	100.00

Packaging material

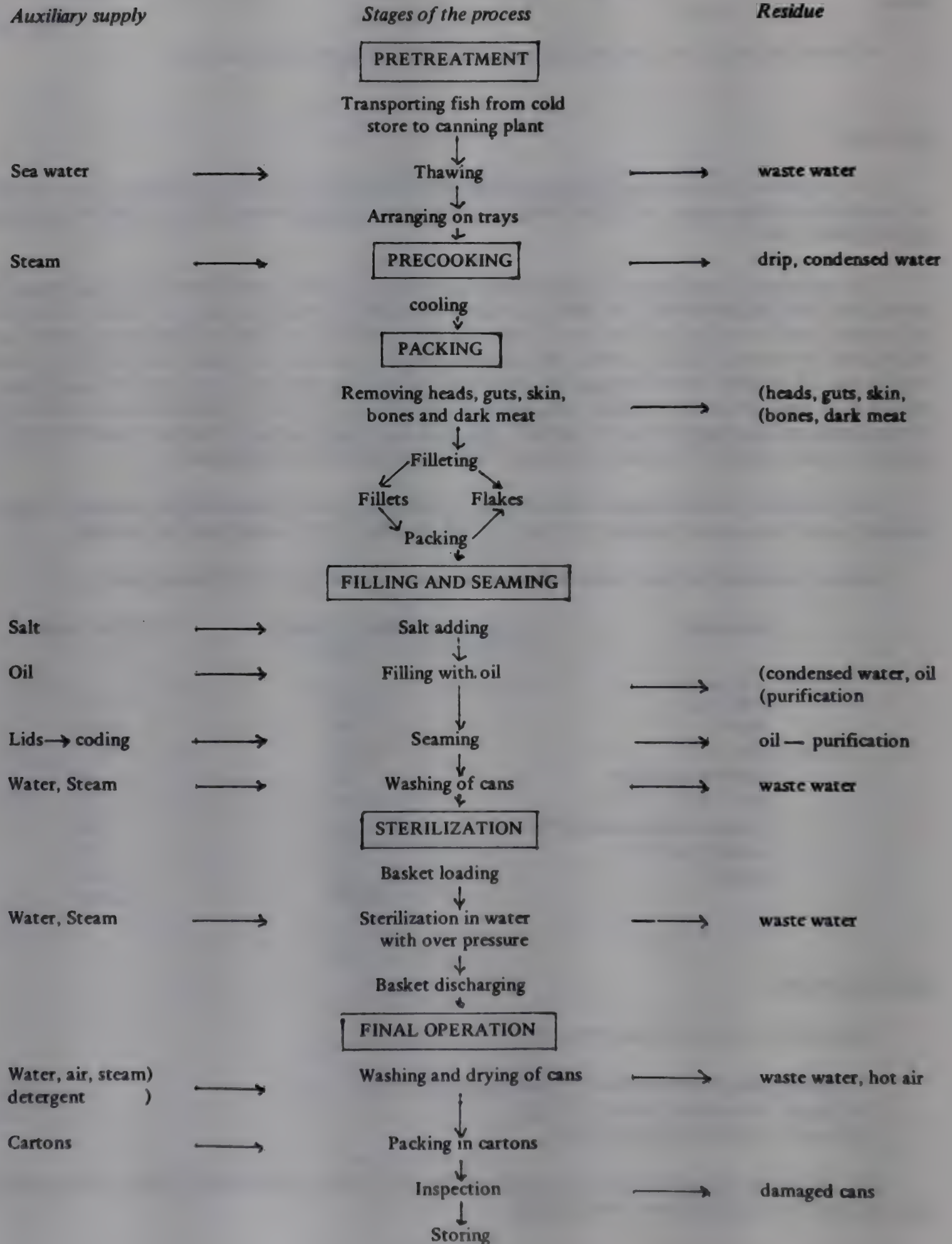
Three different types of cans were used in the experiment:

- 1/4 club 'decollage', made from tin plate, capacity 125 g
- 1/4 dingley aluminium, capacity 115 g
- 1/8 round aluminium, capacity 80 g

The 'decollage' can was closed by an ordinary lid, the dingley can lid had a tongue and a score line for easy opening, and the round can had a 'tear-off' lid.

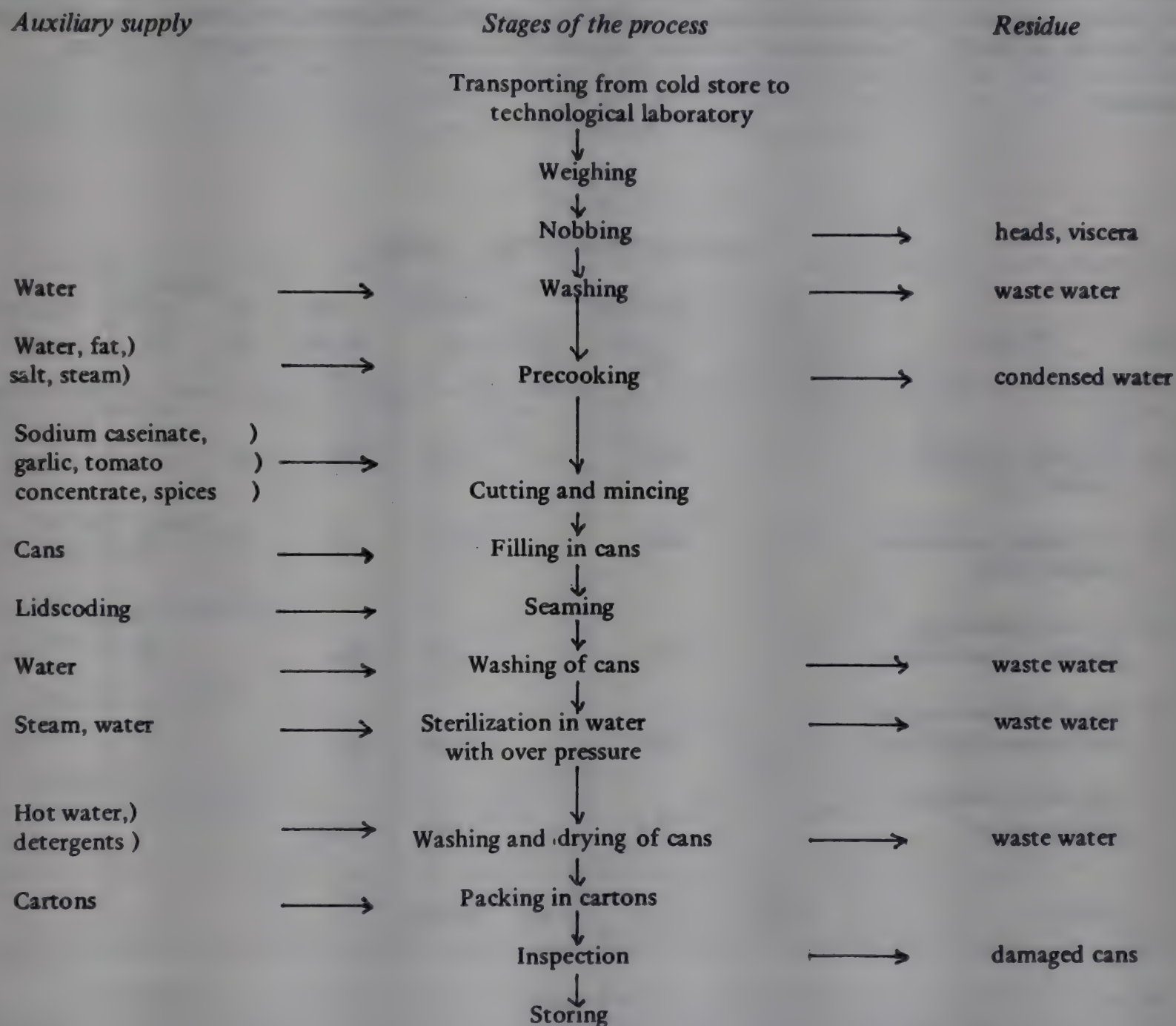
FLOW SHEET 3

Technological Scheme for Tuna Canning



FLOW SHEET 4

Technological Scheme for Fish Spread Canning



The club can is the typical Mediterranean type of can for packing sardines, fillets and similar products; it is not known in India. This type of can was used in the experiment of packing sardines, mackerel fillets and tuna fillets and also for flakes. The dingley can originated from Scandinavian countries and nowadays is generally produced from aluminium. This type of can, but made from tin plate, is used in India for packing sardines in oil. Sardines, mackerel fillets and flakes were packed in dingley aluminium cans during the experiment.

The round can of 80 g capacity is typical for packing spread or paste. The modern 'tear-off' lid permits easy opening, without additional apparatus, which is important in the marketing of canned foods. Sardine and whitebait spread were packed in this type of can.

All products were packed in master cartons, each carton containing 100 cans of 1/4 club 'decollage' type, 112 cans of 1/4 dingley type, or 98 round cans.

RESULTS AND DISCUSSION

The experiments were carried out between 3 and 29 June 1977. Total production was 11 323 cans with eleven different products packed in three types of containers. Product details and yields are given separately for sardine, mackerel, little tuna and whitebait in Tables 1-4. Results of the taste panel assessment for all products are given in Appendix 2. The discussion covers the most important aspects noticed during the experiment.

Sardine

Table 1
Product obtained and yield — sardine

No.	Product	Raw material (kg)	Net meat in cans (kg)	Yield (%)	No. of cans	Fish per can (g)	Medium		Additives (g)
							Oil (g)	Sauce (g)	
1.	1/4 club 'decollage' sardine in oil		446.7		4 467	100	25	—	—
2.	1/4 dingley aluminium sardine in oil		260.0		2 833	92	23	—	—
3.	1/4 club 'decollage' sardine in tomato sauce		87.9		879	100	—	25	—
4.	1/4 dingley aluminium sardine in tomato sauce		96.9		1054	92	—	23	—
5.	1/8 round aluminium sardine spread		35.8		840	42.6	—	—	37.4
Total		1 854	927.2	50	10 073	—	—	—	—

Since more than 20 percent of the fish was not eviscerated by the 'Baader 461', this machine may have to be adapted for the Indian sardine. Alternatively, other types of nobbing machine available in the world market could be tested for nobbing *Sardinella longiceps*.

Precooking is one of the most important operations in the canning of this fish. The 'Utor' continuous cooker developed for precooking small pelagic fish gave excellent results with *Sardinella longiceps* but it will be necessary to make further studies on the time and temperature for precooking. It appears that the second part of the precooking is of significant importance in softening the scales which were not removed before canning. Present sardine canning operations in India include descaling of the fish.

The sterilization regime used in the experiment (115°C, 45 minutes and 2.5 kp/cm² over pressure) was not sufficient for sardine in 1/4 club cans (and possibly the 1/4 dingley cans also) as the backbone and scales were not soft enough.

Sardinella longiceps appears to be a good fish for canning and, because of certain physical properties, it will be easy to produce good quality canned products on a continuous line of the Mediterranean type.

Organoleptic assessment of the quality of canned Sardines by experts from the CFEM was carried out a few days after canning. The result (Appendix 2) indicated that the product was generally 'good' but not 'very good'.

The sardine spread produced with the recipe from CFEM is a good balanced product. The quality is similar to sardine spread made from *Sardina pilchardus*. This recipe could be adapted according to the Indian taste and we believe this product could be an important item for the Indian domestic market.

Mackerel

Table 2

Product obtained and yield — mackerel

No.	Product	Raw material (kg)	Net meat in cans (kg)	Yield (%)	No. of cans	Fish per can (g)	Medium	Additives (g)
							oil (g)	
1.	1/4 club 'decollage' fillets in oil		51.0		510	100	25	—
2.	1/4 dingley aluminium fillets in oil		5.9		64	92	25	—
3.	1/4 club 'decollage' flakes in oil		34.9		349	100	25	—
4.	1/4 dingley aluminium flakes with vegetables		0.58		10	58	—	57
Total		234	98.38	39.5	933	—	—	—

Mackerel fillets were made since there is no similar product in India. There were no problems during the processing operations; the product was good and the quality of fillets was of international standard. The only problem was that the fish used in the experiment were too small for filleting and the total yield was only 39.4 percent, of which 24.0 percent was fillets and 15.4 percent was flakes. Mackerel of this size may be good for packing in dingley cans of 130 g or oval cans of 200 g.

Fish flakes packed in oil are usually a cheap product but flakes can also be used to develop new canned products such as flakes of mackerel with vegetable and tomato sauce. Only tin cans were produced with a mixture of flakes, vegetable and tomato sauce. Quality of the product was very good, but more development is needed for this product.

Little tuna

Processing of only 32 kg of little tuna (*Euthynnus affinis*) was done to check the colour of the meat after canning, and to produce tuna fillets, one of the most valuable types of canned tuna product.

The colour of meat obtained after canning was similar to commercial packs of the same species, being somewhat darker than light meat tunas. Forming of fillets was easy, but total yield and yield of fillets was lower than the yield of other types of tuna canned at 'Adria'. The quantity of tuna was too small for any serious conclusion, especially in the yield of fillets but the taste and smell of the meat was good and was typical for this type of product.

Little tuna

Table 3

Product obtained and yield — little tuna

No.	Product	Raw material (kg)	Net meat in cans (kg)	Yield (%)	No. of cans	Fish per can (g)	Medium		Additives (g)
							Oil (g)	Sauce (g)	
1.	1/4 club 'decollage' tuna fillets in oil		6.50	20.31	65	100	25	—	—
2.	1/4 club 'decollage' tuna flakes in oil		6.30	19.69	63	100	25	—	—
3.	1/4 dingley aluminium tuna flakes with vegetable		0.52	1.63	9	58	—	—	57
	Total	32.0	13.32	41.63	137	—	—	—	—

Whitebait

Table 4

Product obtained and yield — white bait

No.	Product	Raw material (kg)	Net Meat in cans (kg)	Yield (%)	No. of cans	Fish per can (g)	Oil per can (g)	Additives (g)
1.	1/8 round aluminium whitebait spread	15	11.33	75.53	266	42.6	—	37.4
2.	1/4 dingley aluminium whitebait	2	1.19	60.00	13	92.0	17	—
	Total	17	12.52	—	279	—	—	—

The fish spread made from *Stolephorus* spp. had a typical light colour, good odour and taste. Consistency was good but still with some small particles which the cutter was not able to crush. A better consistency could be obtained by using a colloid mill but one was not available for these trials.

This type of minced product is ideal for the utilization of smaller fish such as whitebait (100–350 pieces/kg).

A few cans of nobbed whitebait were produced. The canned product was of inferior quality compared to canned sardines due to its organoleptic characteristics and appearance.

CONCLUSIONS

From these experiments, it can be concluded that the following types of pelagic fish available in India are suitable for canning.

Sardine (Sardinella longiceps)

This fish can be successfully processed by using the canning line for small pelagic fish of the Mediterranean type.

The nobbing machine must be adapted for this type of fish and further studies and trials should be conducted on precooking and sterilization of the fish.

The canned sardine made during the experiment were of good quality and acceptability. They are considered suitable for marketing in domestic and international markets.

Mackerel (Rastrelliger kanagurta)

The quality of the canned mackerel was good; the low yield resulted probably from the relatively small sized fish used in the experiment. It will be necessary to find a suitable type of round can for packing of mackerel of this size.

Little tuna (Euthynnus affinis)

The canned little tuna had a darker colour than light meat tuna packs. Most international markets prefer light meat tuna, so this would probably be acceptable in the 'bonito' market areas. It is also suitable for the development of varied products, such as little tuna with vegetable and tomato sauce.

Fish spread

The canned fish spread produced from *Sardinella longiceps* and *stolephorus* spp., is of similar quality to spread made from *Sardina pilchardus*. This type of product should play an important role in the utilization of Indian whitebait.

Packaging material

Two types of packaging materials were used in the experiment, tin plate and aluminium alloy, and three different types of cans. Though both packaging materials have good canning properties, aluminium alloy is readily available in India and has several advantages over tin plate and is suggested as the packing material to be used in India.

REFERENCES

- Perovic, V., The canning of fish in tropics *In* Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 337-49
1977
- Silas, E.G., S.K. Dharmaraja and K. Rengarajan, Exploited marine fishery resources of India; a synoptic survey with comments on potential resources. *Bull. Cent.Mar.Fish.Res.Inst., Cochin*, (27): 25 p.
1976

APPENDIX 1

*Chemical Analysis of Raw Material***Sardine (*Sardinella longiceps*)***percent*

Moisture	69.56
Oil	12.82
Protein	15.11
Ash	2.15

Indian mackerel (*Rastrelliger kanagurta*)*percent*

Moisture	68.13
Oil	9.56
Protein	18.87
Ash	2.58

Whitebait (*Stolephorus* spp.)*percent*

Moisture	73.11
Oil	7.27
Protein	16.63
Ash	2.61

Little tuna (*Euthynnus affinis*)

Due to small amount of fish, chemical analysis was not made.

APPENDIX 2

Panel Assessment of the Quality of Canned Fish

Features	Product							
	Sardine in oil	Sardine in sauce	Mackerel fillets	Mackerel flakes	Tuna fillets	Tuna flakes	Spreads Whitebait	Sardine
<i>Appearance</i>								
Very good	—	—	—	—	—	—	—	—
Good	x	x	x	x	x	x	x	x
Satisfactory	—	—	—	—	—	—	—	—
<i>Odour</i>								
Very good	x	—	—	—	—	—	—	—
Good	—	x	x	—	x	—	x	x
Satisfactory	—	—	—	—	—	x	—	—
<i>Taste</i>								
Very good	—	—	—	—	—	—	—	—
Good	x	—	x	—	x	—	x	x
Satisfactory	—	x	—	x	—	x	—	—
<i>Texture</i>								
Very good	—	—	—	—	—	—	—	—
Good	x	x	x	—	x	—	x	x
Satisfactory	—	—	—	x	—	x	—	—

CHEMICAL AND TASTE PANEL TESTS ON THE MECHANICALLY SEPARATED FLESH OF SIX TROPICAL FISH SPECIES

by

H. Allan Bremner

CSIRO Division of Food Research, Tasmanian Food Research Unit,
Stowell, Tasmania, Australia

and

P.J.I. Snell

Fisheries Department, Kota Kinabalu, Sabah, Malaysia

Abstract

Experimental blocks of the mechanically separated (minced) flesh of six tropical species of fish were examined chemically and by taste panel evaluation. The six species: grunter (*Pomadasys argyreus*), lizard fish (*Saurida tumbil*), catfish (*Arius* spp.), pony fish (*Leiognathus splendens*), threadfin bream (*Nemipterus japonicus*) and ribbon fish (*Trichiurus lepturus*) are common in Malaysian waters.

The results of the chemical determinations, crude protein, moisture, total lipid, saline, extractable protein, trimethylamine oxide, dimethylamine, formaldehyde, trimethylamine, free fatty acid, thiobarbituric acid value, and bone content are reported and discussed. Taste panel evaluations were carried out on both the minces and on fish fingers made from the minces, using an Australian taste panel. These results are considered in relation to previous work on Australian species.

INTRODUCTION

In the course of prawn trawling operations there is often a considerable by-catch fish species of various sizes and character. In Sabah, surveys have been made to find out the most common species which make-up the by-catch (Snell and Chin, 1978). Many of the larger fish can be sold on the fish market but the smaller specimens are often discarded.

One way of utilizing the by-catch is by mechanical separation of the flesh from the fish and use of the resultant mince as a manufacturing material for various food products; Snell (1978) has reported on the use of minced flesh from Malaysian species in products, such as fish balls, which are produced locally.

This paper reports the results of chemical and taste panel tests obtained on the mechanically separated flesh of six Malaysian fish species which commonly occur as by-catch during prawn trawling and on the suitability of this mince as a raw material for fish finger production.

MATERIALS AND METHODS

Materials

The six species of fish investigated are listed in Table 1. They were caught, early in 1977, in 20-25 fathoms in the bay of Kota Kinabalu, Sabah, Malaysia. The fish were iced immediately after catching. The following morning they were sorted, washed, gutted, headed and re-iced. In the afternoon they were processed through a Yanagiya Miny meat separator with a pore size of 4 mm in the separating drum. The mince was not screened or washed. It was packed in polyethylene bags inside galvanized containers of the type in which prawns are frozen. The samples were frozen in a shelf freezer and held in a cold store (approximately -22°C) before being packed in dry ice in an insulated container and dispatched by air to the CSIRO Tasmanian Food Research Unit, Hobart, Australia.

The samples arrived still frozen, packed in the remaining dry ice, and were stored at -18°C until required.

Sufficient material for testing was cut from each block with a bandsaw and allowed to thaw overnight at 1°C , the remainder were returned to the freezer. Each test sample was divided into three portions, one portion was used for chemical tests and the others for taste panel evaluation.

Table 1

Species, weight ranges of fish processed and yields of mince

Common English name	Scientific name	Date caught	Date processed	Weight range ^{a/} (g)	Weight processed (kg)	Yield of mince (%)
Granter	<i>Pomadasys argyreus</i>	24 & 25/1/77	26/1/77	10–60	10	24
Lizard fish	<i>Saurida tumbil</i>	3/2/77	4/2/77	60–330	17	52
Catfish	<i>Arius</i> spp. ^{b/}	24 & 25/1/77	26/1/77	50–580	Na ^{c/}	NA ^{c/}
Pony fish	<i>Leiognathus splendens</i>	3/1/77	4/2/77	25–50	44	36
Threadfin bream	<i>Nemipterus japonicus</i>	24/ & 25/1/77	26/1/77	20–75	12	53
Ribbon fish	<i>Trichiurus lepturus</i>	8/3/77	9/3/77	75–480	14	54

a/ From a representative sample of twenty fish

b/ A single species, not identified

c/ Not available

Fish fingers were prepared from further portions of the frozen blocks as previously outlined (Bremner, 1977a) by cutting fish finger shapes from the blocks, dipping in a batter and breadcrumb mix and deep frying for 1 min at $190-195^{\circ}\text{C}$. The fish fingers were then cooled on rocks and frozen and aluminium foil packages at -18°C until required.

Methods

Chemical

The methods have been given in more detail previously (Bremner, 1977b) but are summarized here. The pH was measured directly on the fish flesh with a cheese electrode; moisture by oven drying overnight at 105°C ; crude protein (Nx6.25) by the Kjeldahl-Wilfarth-Gunning method; total lipid by the extraction method of Hanson and Olley (1963); saline extractable protein (SEP) by the method of Anderson and Ravesi (1968); tri-

methylaniline (TMA) by the method of Tozawa *et al.* (1971); trimethylaniline oxide (TMAO) by the method of Tozawa *et al.* (1971) after reduction to TMA with titanium trichloride (TiCl_3) (Yamagata *et al.*, 1969); thiobarbituric acid value (TBA) by the method of Vyncke (1970) but on a perchloric acid extract; dimethylaniline (DMA) by the method of Dowden (1938), formaldehyde (FA) by the method of Nash (1953); free fatty acid (FFA) on the extracted lipid by the method of Duncombe (1963) and bone content by the method of Dingle *et al.* (1974).

The minces were analysed by the above methods in March 1977 and again, for some variables, two months later.

Taste panel

The preparation and presentation of the samples to the taste panel followed the procedures reported previously (Bremner, 1977a). Portions of fish mince (200 g) were heated for 1 h in a stainless steel dish, fitted with a lid, in a water bath set at 60°C. The heated fish was served to the panel in preheated glass jars marked with abstract symbols. The panel were asked to mark the samples for aroma, off-aroma, flavour, off-flavour, toughness, moisture (moistness) and acceptability on nine-point scales; the higher the scale the greater the attribute except in the case of toughness and moisture where the mid-point (5) of the scale was designated as preferred texture and normal moisture respectively. The panel of nine staff members, who were experienced in tasting fish minces in this manner, were also asked to comment on the samples.

The fish fingers were heated for 45 min in an oven set at 180°C and were served on the wire trays on which they were heated. The panel for the fish finger evaluation consisted of seven of the previous panel members and the same score sheet was used.

For both fish minces and fish fingers all six samples were presented in random order to each panelist at two sessions, one mid-morning the other mid-afternoon. The results were examined by analysis of variance.

RESULTS

Process observations

The fish of all six species were small (Table 1), particularly the pony fish and the granter but in practice the larger catfish, threadfin bream and ribbon fish would be sold on the fresh fish market.

The granter were difficult to clean and scale, the flesh being soft and dark. The catfish had many spines and the brownish flesh contained many blood vessels. The pony fish were difficult to head and gut and contained many small bones while the ribbon fish had a thin skin which was easily torn and became more fragile on standing. The yields varied considerably and, since they are based on such small weights of fish processed, should only be taken as a guide.

Appearance of the minced blocks

The granter was light grey in colour with some scales present; the lizard fish was a light white pink in appearance; the catfish was red-brown in colour like a meat mince; the pony fish was a light grey yellow; the threadfin bream was a light pink-brown with some fine scales evident, while the ribbon fish was dark grey-brown in colour with many silvery flecks. The catfish, threadfin bream and ribbon fish were much darker than any Australian species investigated (Bremner, 1977c) with the exception of tuna.

Table 2

Analytical results obtained on the fish minces^{a/} (March, 1977)

	Units	Granter	Lizard fish	Catfish	Pony fish	Threadfin bream	Ribbon fish
pH		6.5	6.7	6.6	6.8	6.9	6.5
Crude protein	g/100g	16.0	17.6	15.3	16.1	15.9	17.8
Moisture	g/100g	81.3	80.0	82.1	82.5	82.1	79.7
Total lipid	g/100g	1.1	1.1	1.3	1.0	1.1	1.9
Salt extractable protein (SEP)	g/100g	12.1	5.2	8.9	13.2	13.8	9.4
Protein extractability	%	75.6	29.5	58.2	82.0	86.8	52.8
Trimethylamine oxide (TMAO)	mg/kg	1 820.0	540.0	230.0	970.0	1 580.0	1 700.0
Trimethylamine (TMA)	mg/kg	0	30.0	0	0	0	15.0
Dimethylamine (DMA)	mg/kg	3.0	790.0	2.8	13.3	4.9	3.3
Formaldehyde (FA)	mg/kg	0.6	141.0	0.6	1.4	0.5	0.5
Free fatty acid (FFA)	mg/100g	52.0	41.0	65.0	95.0	68.0	51.0
Thiobarbituric acid value (TBA)	mg/kg	1.0	1.5	1.4	0.8	1.4	4.0
Bone	g/100g	0.27	0.12	0.06	0.09	0.13	0.06

^{a/} Means of triplicate analyses*Chemical results*

The results obtained on the minces in March, 1977 are shown in Table 2; results from the later analysis are mentioned only where appropriate.

No species could be described as fatty, but it should be noted that the ribbon fish contained nearly twice as much lipid as the other species. The saline extractable protein values (SEP) indicate some denaturation of the myofibrillar protein and this is to be expected when minced fish has been stored for a short period (cf. Bremner, 1978); the low value for the lizard fish indicates almost complete denaturation of the myofibrillar proteins. Later analysis showed further denaturation of the protein of this fish (protein extractability 20 percent) but virtually no change in the SEP of the other species.

The trimethylamine oxide (TMAO) levels are in the range of published values for marine teleosts (Love *et al.*, 1959; Sumner and Perry, 1977) with the exception of the catfish in which the low value (312 mg/kg) resembles the levels found in freshwater fish. Velankar and Govindan (1958), however, found 1 930 mg/kg of TMAO in the edible flesh of the related species *Arius sona*. The function of TMAO is regarded as being that of osmoregulation (Love, 1970) and low levels might have indicated that the present fish were caught in water of low salinity; however, this was not the case.

Bacterial degradation of TMAO to TMA had occurred only in two species, lizard fish and ribbon fish and, when expressed as TMA nitrogen per 100 g flesh, it can be seen that the levels (0.7 and 0.35 mg TMA N/100 g respectively) are well below the proposed maximum levels of 5 to 10 mg TMA N/100 g (FAO, 1969).

In frozen storage, TMAO can be converted enzymically to DMA and FA; this occurred to a considerable extent in the lizard fish and the FA production would appear to account for the protein denaturation as indicated by low SEP values (Sikorski *et al.*, 1976). Further increases in DMA were noted in later analysis on this fish. The FFA levels in the minces were relatively low (cf. Olley *et al.*, 1962) but, by the time of the later analysis, had all risen by a factor of three indicating the presence of active phospholipases and, possibly, lipases in the flesh. The TBA levels were all low except in the ribbon fish which contained the most lipid; this may indicate a relatively lower stability toward oxidation of the lipid. After two months the TBA values found were all lower except for the threadfin bream where the value increased slightly. Fluctuating TBA values in stored minces have been reported previously by Bremner (1978).

The bone content of the granter mince was high but the value is inflated due to the large amounts of scale which register as bone in the analysis. While the values appear quite low on a percentage basis, the trade would require even lower levels. The bone content can be reduced by attention to screen sizes and belt tensions used. The problem is exaggerated because many of the fish were very small.

Taste panel results

Fish minces

The results of the taste panel evaluation on the minces are shown in Table 3. The fish were unfamiliar to the panel and the aroma and flavour were different from most types tested previously. Consequently, the natural aroma and flavour of some species may have been classified as off-aroma and off-flavour; a high score in these 'off' categories is probably not due to deterioration before, during or after processing. Nevertheless, the scores represent the impressions of this Australian panel. It should also be noted that fish of widely differing flavour may be given similar scores for fish flavour intensity but, in this context, the scores should be examined in conjunction with the taste panel comments which are listed in Table 4. It should be realized that some of the comments may well convey a different meaning to different racial groups.

Pony fish was the most acceptable of the six species although none of the minces was rated highly by the panel; high off-aroma and off-flavour scores coupled with low aroma and low flavour scores were common. The flesh of the lizard fish was marked as being tough and dry and the granter also tended to be tough and dry.

These texture attributes have been plotted on a toughness moisture diagram (Fig. 1) which clearly shows how the results fit on a continuum from soft and wet to tough and dry. This approach has proved valuable previously in highlighting differences between species (Bremner *et al.*, 1978) and in the present case, the soft and wet nature of the samples of catfish and threadfin bream are evident.

Table 3
Taste panel scores for cooked minces^{a/} (Scale 1-9)

Species	Aroma	Off-aroma	Flavour	Off-flavour	Toughness	Moisture	Acceptability
Granter (<i>P. argyreus</i>)	3.9	2.6	4.2	2.1	7.0	4.2	4.6
Lizard fish (<i>S. tumbil</i>)	4.0	3.4	5.1	2.9	7.4	3.2	3.6
Catfish (<i>Arius</i> spp.)	3.9	5.3	4.4	3.7	2.8	5.9	3.1
Pony fish (<i>L. splendens</i>)	4.5	3.9	4.9	2.4	3.8	5.4	5.0
Threadfin bream (<i>N. japonicus</i>)	3.4	2.9	3.3	2.3	1.6	6.3	2.7
Ribbon fish (<i>T. lepturus</i>)	4.2	3.8	5.2	3.9	4.6	4.9	4.6
Least significant differences $P < 0.05$	0.7	0.9	0.8	0.9	0.6	0.7	0.8

a/ Each score is a mean of 18 judgements (9 panelists x 2 sessions)

Table 4
Taste panel comments on fish minces

Species	Aroma and off-aroma	Flavour and off-flavour	Toughness and moisture	Acceptability
Granter (<i>P. argyreus</i>)	Milky Meaty Sweet	Tasteless Sweet Mushrooms	Fibrous, gritty Pasty Slightly rubbery Very chewy Gritty Bones Shewy Rubberbands Wet-dry	
Lizard fish (<i>S. tumbil</i>)	Cucumber fish Flat Sweetish, not pleasant Musty Sharp, vinegary Sweet, unpleasant	Cucumber fish Rancid Musty Sweet	Rubbery Dry Fibrous, scales Chewy Wet-dry (formaldehyde producer) Poor texture	
Catfish (<i>Arius</i> spp.)	Like flathead Ammonia Sickly sweet Sharp smell Sweet hay Sweetish, not pleasant Putrid Rancid Ammonia, unpleasant Sweet, unpleasant	Quite pleasant Soapy Mushrooms Odd, nonfish Urine Meaty Bitter	No texture Pasty	
Pony fish (<i>L. splendens</i>)	Rock cod Sickly sweet Cut flower	Sandy, weedy Oysters Seaweed	Too soft Granular-like Sago	Good

Pasty
Gritty, scales
Mushy
Pasty

Iodine, oyster

Sweetish, not
pleasant

Ammonia

Pungent seaweed

Chlorine

Acrid

Cucumber fish

Ammonia

Flat

Meaty

Mushrooms

Bland

Musty

Threadfin bream (*N. japonicus*)

Soft

Mushy

Sloppy

No texture

Gritty

Bones

Pasty

Soft, granular

Weak

Wet paper

Prawns

Mushrooms

Bitter

Cotton wool

Ribbon fish (*T. lepturus*)

Urine

Pungent

Meaty

Bit cabbagey

Ammonia

Musty

Sharp, odd

Dirty

Grassy

Sweet, unpleasant

Pungent green

Bit bitter

Sharky

Tuna-like

Poor flavour

Pasty

Sloppy

Sago-like

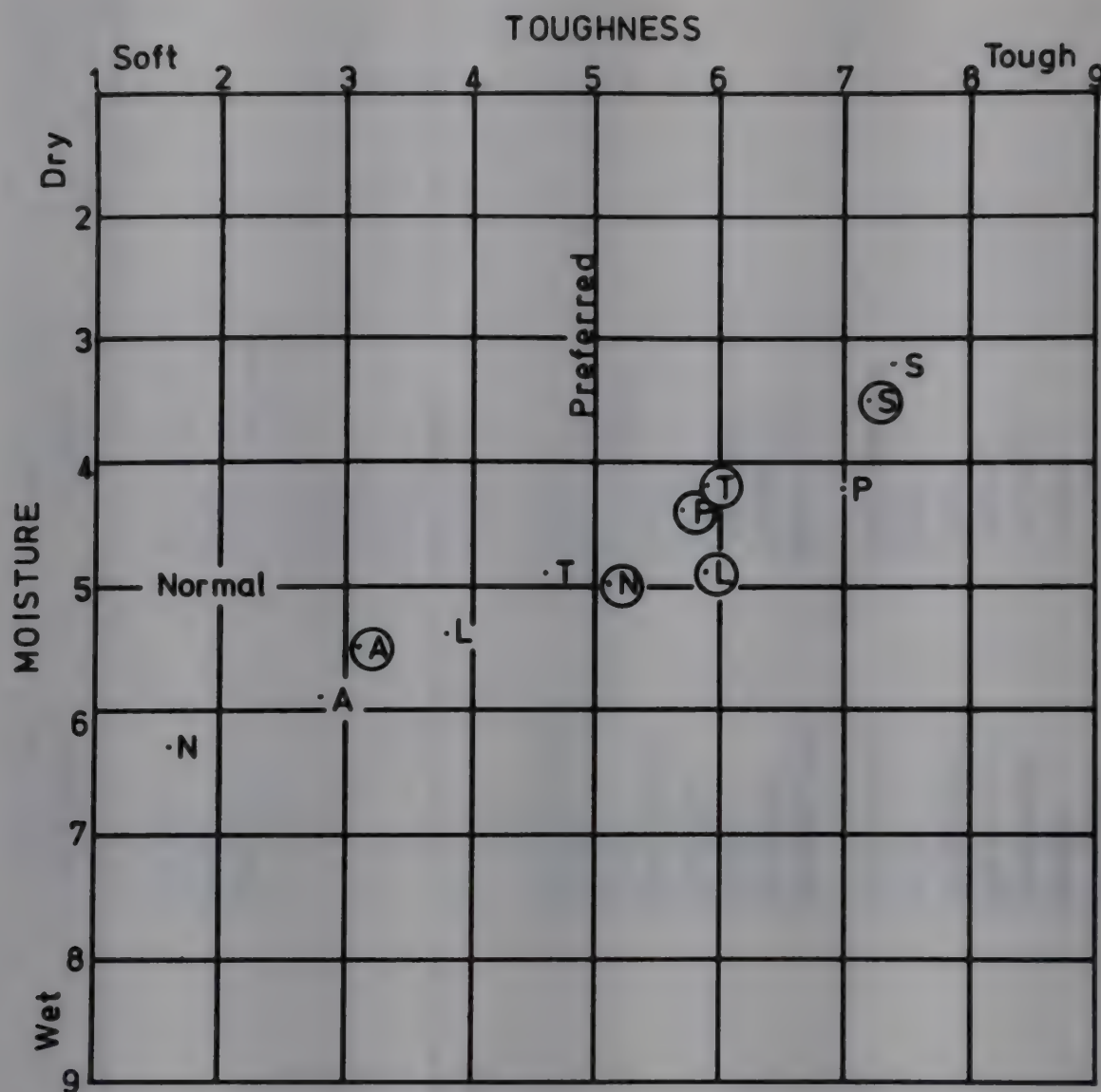


Figure 1 Taste panel scores for toughness and moisture plotted on a scatter diagram

P = Granter

S = Lizard fish

A = Catfish

L = Pony fish

N = Threadfin bream

T = Ribbon fish

The values for fish fingers are encircled

Fish fingers

The taste panel results obtained for the fish fingers are listed in Table 5 and the corresponding comments in Table 6. Again, the two tables should be examined in conjunction. It should be noted that the scores for the minces and the fish fingers are not strictly comparable; not only were the panel sizes different (9 and 7 respectively), but also they were never tasted together at one session. Nevertheless, the fish fingers made from the lizard fish were tough, as was the mince, whereas the fish fingers from the threadfin bream, where the minces were very soft, were of acceptable texture; this is shown in Fig. 1. This marked difference in toughness rating between minces and fish fingers has been noted before in this laboratory with the species morwong (*Cheilodactylus macropterus*) and nannygai (*Centroberyx affinis*).

Table 5

Taste panel scores for fish fingers^{a/} (Scale 1-9)

Species	Aroma	Off-aroma	Flavour	Off-flavour	Toughness	Moisture	Acceptability
Granter (<i>P. argyreus</i>)	3.4	2.4	4.1	3.4	5.7	4.4	4.4
Lizard fish (<i>S. tumbil</i>)	2.4	3.9	3.2	4.1	7.2	3.5	3.3
Catfish (<i>Arius</i> spp.)	2.6	4.5	4.1	5.1	3.1	5.5	3.1
Pony fish (<i>L. splendens</i>)	2.5	2.9	4.6	3.9	5.9	4.9	3.6
Threadfin bream (<i>N. japonicus</i>)	2.9	2.5	4.4	2.2	5.1	5.0	5.1
Ribbon fish (<i>T. lepturus</i>)	3.9	2.9	5.6	3.2	5.9	4.2	4.5
Least significant difference $P < 0.05$	1.0	1.1	1.2	1.4	1.0	0.8	1.3

a/ Each score is a mean of 14 judgements (7 panelists x 2 sessions)

Table 6

Taste panel comments on fish fingers

Species	Aroma and off-aroma	Flavour and off-flavour	Toughness and moisture	Acceptability
Granter (<i>P. argyreus</i>)	Nutty Ammonia Salty	Weedy Iodine Nutty Musty Stale	Tough	Peculiar Ammonia, soft texture Too soft, tasteless Weedy
Lizard fish (<i>S. tumbil</i>)	Sweet batter Pleasantly fishy Nutty Cardboard	Grassy Oily off-taste Nutty Oily Stale Meaty	Rubbery Tough Woolly	Poor texture Tasteless
Catfish (<i>Arius</i> spp.)	Faecal Ammonia Grassy Fruity Acid	Meaty Stale Bitter Nutty	Squashy	Dark Poor texture Peculiar Ammonia, soft texture Too soft
Pony fish (<i>L. splendens</i>)	Batter Ammonia Stale Cardboard	Sweet Stale Nutty Musty	Tough	Soft, tasteless Peculiar Ammonia Soft texture
Threadfin bream (<i>N. japonicus</i>)	Cardboard Salty Sweet	Salty Soapy Stale Nutty	Granular	Poor texture
Ribbon fish (<i>T. lepturus</i>)	Like Australian salmon Vinegary Meaty Cardboard Pleasantly sweet	Rancid Oily Slightly rancid Stale Nutty Tuna-like	Tough	Downgraded on off-flavour Revolting

Some of the taste panel comments about fish fingers probably pertain more to the combination of batter, breadcrumbs and drying oil than to the fish. One panelist, who consistently gave samples a lower toughness score than the rest of the panel, is also responsible for the comments on the soft texture (in the acceptability column) of the granter and pony fish fingers, when the panel, as a whole, considered these samples to be slightly tough.

The threadfin bream improved from being the least acceptable as a mince to being the most acceptable as a fish finger. However, it would still be classed low in acceptability in comparison with previous samples prepared and tasted in the same manner by members of this panel (cf. Bremner, 1977c).

DISCUSSION

Relationship between chemical and taste panel results

The tough and dry nature of the lizard fish can presumably be attributed to the production of FA which results in rapid denaturation and accompanying toughening of the flesh (cf. Sikorski *et al.*, 1976). The lizard fish (family Synodontidae) belongs to the order Myctophiformes in the superorder Scopelomorpha (Nelson, 1976) and it is interesting to note that another member of this order, i.e., the cucumber fish (*Chlorophthalmus nigripinnis*) of the family Chlorophthalmidae also produces FA in frozen storage (Bremner, 1977b). Some members of the taste panel noted the similarity in aroma and flavour of the lizard fish sample to that of cucumber fish (Table 4). Also two panelists noted the same wet-dry phenomenon that occurs on chewing cucumber fish mince, when the moisture readily escapes from the toughened fish flesh leaving a dry fibrous wad in the mouth. On this basis, one panellist guessed that the sample was a formaldehyde producer. It is possible that this property of producing FA may be present in other genera of the order Myctophiformes, as is apparently the case in the order Gadiformes, where genera represented by cod, hake, saithe, pollack and grenadier all produce FA in frozen storage. With the exception of the grunter, the results obtained on the fish minces reported here fit the concept of the relationship of toughness scores with pH and SEP levels (Bremner *et al.*, 1978). The grunter mince was tougher than would be expected from its pH and SEP values; there is no alternative explanation from the chemical analyses. The threadfin bream would be expected to be soft from its relatively high pH and SEP level but, even so, its toughness score of 1.6 units is exceptionally low. The comments demonstrate that the panel was able to detect bone and scale in nearly all the minces.

Relationship of acceptability with other sensory attributes

The individual sensory scores have been plotted against acceptability (Fig. 2). The data from both the fish minces and fish fingers have been used since the relationships of sensory attribute to acceptability, for the purposes of illustration, can be considered the same. The curves for the aroma, off-aroma, flavour and off-flavour diagrams were derived by geometric mean regression (Ricker, 1973) and clearly show the positive contributions to acceptability made by aroma and flavour and the negative role of off-aroma and off-flavour. Similar figures derived from data on Australian species have been shown by Bremner (1978). The toughness curve was drawn by eye but no curve is suggested for the moisture diagram. The relationship of moisture and toughness scores with acceptability cannot be linear because the scoring scales have their optimum value at the mid-point (5). The resulting quadratic nature of the relationship with acceptability is evident in the toughness diagram. The present results are consistent with those of Laslett and Bremner (1978), who used the data from a number of tasting experiments on fish minces (using the same scoring system as employed here) to investigate the inter-relationships of the sensory variables with acceptability.

CONCLUSION

The results, particularly those from the taste panel, demonstrate the difficulties in obtaining suitable flesh from trash fish. In this case there were considerable difficulties in preparing the fish; this was mainly because the fish were small and resulted in unacceptable levels of bone and scale in the mince. The colour of the minced flesh, too, was poor even though it is possible to separate, by hand, acceptable light coloured flesh from ribbon fish, pony fish and lizard fish.

The fish were not very acceptable to the Australian panel even in the popular form of fish fingers. Presentation of the fish to the panel in the two forms showed how the relative rating of a particular species could change, demonstrating that sensory and acceptability trials should be made on the exact product which is to be sold to the public.

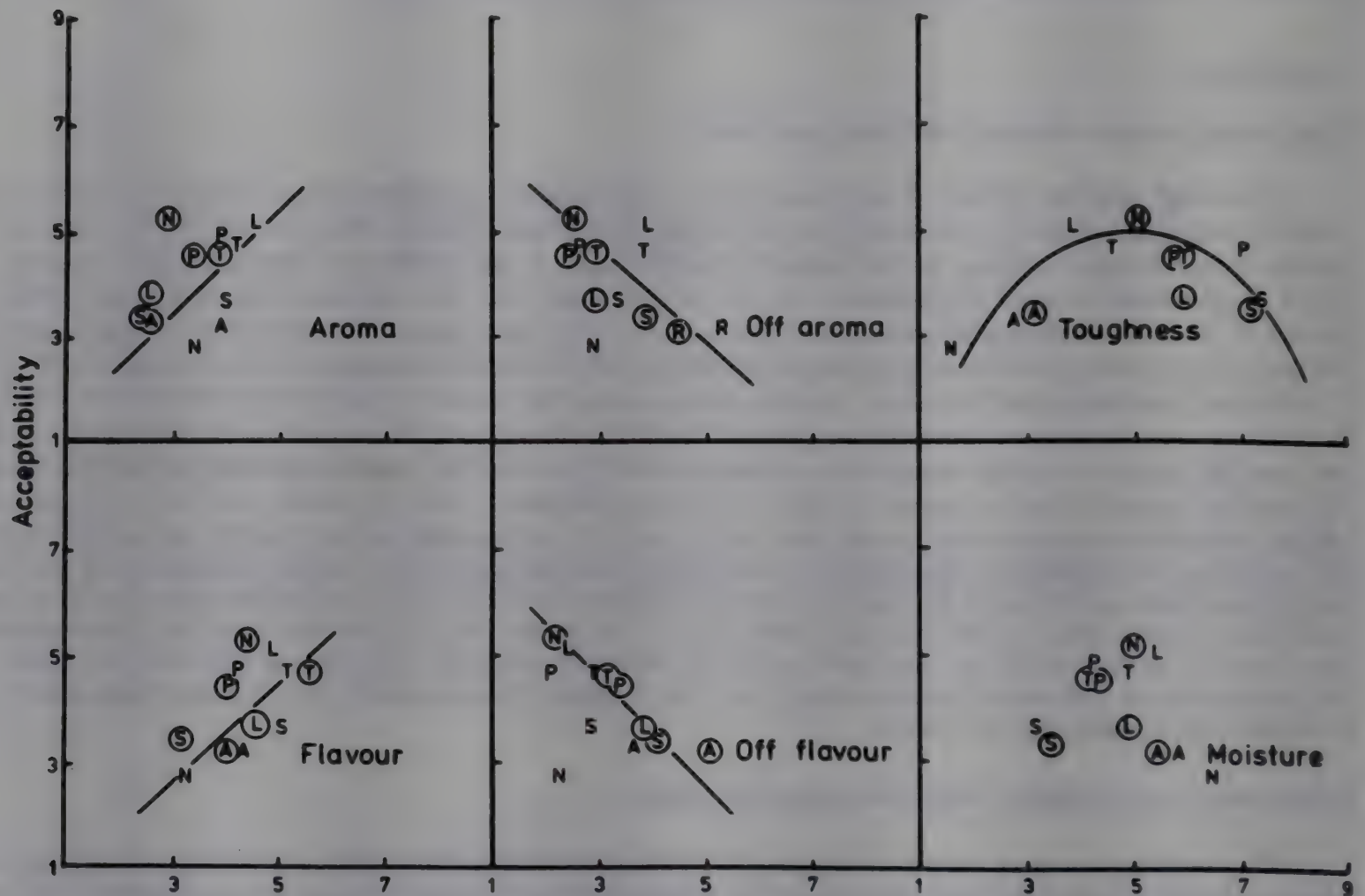


Figure 2 Taste panel score for acceptability of fish minces and fish fingers plotted against the six sensory attributes

P = Granter
S = Lizard fish
A = Catfish

L = Pony fish
N = Threadfin bream
T = Ribbon fish

The values for fish fingers are encircled

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the support of the Director and staff of the Department of Fisheries, Sabah, and the skilled technical assistance of Ms. A. Wright for carrying out the taste panel work and the chemical analyses in conjunction with Mr. A. Vail.

REFERENCES

- Anderson, M.L. and E.M. Ravesi, Relation between protein extractability and free fatty acid production in cod muscle aged in ice. *J.Fish Res.Board Can.*, 25(10):2059-69
1968
- Bremner, H.A., Storage trials on the mechanically separated flesh of three Australian mid-water fish species. 2. Taste panel evaluation. *Food Technol.Aust.*, 29:183-8
1977
- Bremner, H.A., Storage trials on the mechanically separated flesh of three Australian mid-water fish species. 1977a 1. Analytical tests. *Food Technol.Aust.*, 29:89-93
- _____, Production and storage of mechanically separated flesh from Australian species. In Fishexpo '76 Seminar. Report of proceedings. Melbourne, 21-23 Sept. 1976. Canberra, Australian Government Publishing Service, pp. 319-32
1977b
- _____, Mechanically separated fish flesh from Australian species—a summary of results of storage trials. *Food Technol.Aust.*, 30 (in press)
1978
- Bremner, H.A., G.M. Laslett and J. Olley, Taste panel assessment of textural properties of fish minces from Australian species. *J.Food Technol.*, (in press)
1978
- Dingle, J.R. *et al.*, The measurement of the bone content in minced fish flesh. In Second Technical Seminar on Mechanical Recovery and Utilization of Fish Flesh, edited by R.E. Martin. Washington, D.C., National Fisheries Institute, pp. 282-90
1974
- Dowden, H.C., The determination of small amounts of dimethylamine in biological fluids. *Biochem.J.*, 32: 445-9
1938
- Duncombe, W.G., The colorimetric micro-determination of long chain fatty acids. *Biochem.J.*, 88:7-10
1963
- FAO, Report of Working Group on trimethylamine. *FAO Fish.Rep.*, (81):39-43
1969
- Hanson, S.W.F. and J. Olley, Application of the Bligh and Dyer method of lipid extraction to tissue homogenates. *Biochem.J.*, 89:101-2
1963
- Laslett, G.M. and H.A. Bremner, (in preparation)
1978
- Love, R.M., The chemical biology of fishes. London, Academic Press, 145 p.
1970
- Love, R.M., J.A. Lovern and N.R. Jones, The chemical composition of fish tissues. *Spec.Rep.Food Invest.Board D.S.I.R., G.B.*, (69):37 p.
1959
- Nash, T., The colorimetric estimation of formaldehyde by means of the Hantzsch reaction. *Biochem.J.*, 55:416-21
1953
- Nelson, J.S., Fishes of the world. New York, John Wiley and Sons, 416 p.
1976

- Olley, J., R. Pirie and H. Watson, Lipase and phospholipase activity in fish skeletal muscle and its relationship to protein denaturation. *J.Sci.Food Agric.*, 13:501-16
1962
- Ricker, W.E., Linear regressions in fishery research. *J.Fish Res.Board Can.*, 30(3):409-34
1973
- Sikorski, Z.E., J. Olley and S. Kostuch, Protein changes in frozen fish. *CRC Crit.Rev.Food Sci.Nutr.*, 8:97-129
1976
- Snell, P.J.I., The production of fish balls and fish cakes in Sabah and the use of trawler by-catch for such products. Paper presented to the IPFC Symposium on fish utilization technology and marketing. Manila, Philippines
1978
- Snell, P.J.I. and P.K. Chin, The trawling industry in Sabah and its noncommercial fish catch. Paper presented to IPFC Symposium on fish utilization technology and marketing. Manila, Philippines
1978
- Sumner, J.L. and I.R. Perry, Spoilage of some New Zealand fish species. 1. Held in ice. *Food Technol.N.Z.*, 12(5):19-24
1977
- Tozawa, H., K. Enokihara and K. Amano, Proposed modification of Dyer's method for trimethylamine determination in cod fish. *In* Fish inspection and quality control, edited by R. Kreuzer. London, Fishing News (Books) Ltd., pp. 187-90
1971
- Velankar, N.K. and T.K. Govindan, A preliminary study of the distribution of non-protein nitrogen in some marine fishes and invertebrates. *Proc.Indian Acad.Sci.(B)*, 47:202-9
1958
- Vyncke, W., Direct determination of the thiobarbituric acid value in trichloroacetic acid extracts of fish as a measure of oxidative rancidity. *Fette, Seifen, Anstrichmitt.*, 72:1084-7
1970
- Yamagata, M., K. Horimoto and C. Nagaoka, Assessment of green tuna: determining trimethylamine oxide and its distribution in tuna muscle. *J.Food Sci.*, 34:156-9
1969

UTILIZATION OF TILAPIA, A TRASH FRESHWATER FISH

by

M.S. Ismail and A. Zain
Department of Food Science and Technology
Universiti Pertanian Malaysia
Serdang, Selangor, Malaysia

Abstract

Sixty-five percent (301 million) of the people whose diet is insufficient live in the Far East. Their daily protein supply decreased from 51.3 g per person in 1961 to 50.7 g per person in 1971. Fish is an important source of protein in South-East Asia but consumption is limited by price, supply, distribution and season, especially amongst the poor. Most fish comes from marine sources and, in Malaysia, fish from aquaculture form less than one percent of the total although there are 100 000 acres (40 000 ha) of freshwater bodies suitable for aquaculture, in West Malaysian alone.

Tilapia is a tropical freshwater fish which is common and its vigorous breeding and growing capacity are such that it is considered a pest in aquaculture. It has no market value and no known commercial utilization in Malaysia. However, four acceptable products were developed using tilapia:

1. Fish sauce, produced by a rapid fermentation using *Aspergillus oryzae*;
2. 'Pekasam', fermented with rice and consumed after frying or roasting in banana leaves;
3. Canned in tomato sauce;
4. Salted and dried.

The protein content and quality of these products are discussed.

INTRODUCTION

It is estimated that 460 million people in the world today consume insufficient protein and calories, i.e., three percent of the population (28 million) in the developed regions of the world and 25 percent of the population in developing regions (432 million) (FAO, 1975). In some areas, up to 70 percent of the children suffer from a degree of malnutrition; among children of 1 to 4 years of age, the death rate may be 50 to 60 times greater than in developed countries (Stillings, 1967). The effect of malnutrition on the mental and physical health of the surviving children has been widely documented (Berg, 1973; Berg *et al.*, 1971; Latham and Cobos, 1971; Kallen, 1973; Latham, 1970; Wurtman and Fernstrom, 1974).

About 65 percent of these unfortunate people (301 million) live in the Far East. Their daily protein consumption has decreased from an average of 51.3 g per person in 1961 to 50.7 g per person in 1971, although their average energy supply increased from 92 percent of daily requirement (2 050 kcal/person) to 94 percent (2 080 kcal/person) in the same period of time (FAO, 1975).

One of the most important sources of animal protein in South-East Asia is fish. The relatively high price and limited supply of fish have hindered the trend toward a higher consumption of fresh fish. In Malaysia, fish supplied 50-80 percent of the total protein intake (Kong, 1964). Most of these fish were from marine sources; less than 1 percent of the total fish harvested was from aquaculture (Malik, 1977). Yet, there are more than 100 000 acres (40 000 ha) of freshwater bodies which are suitable for aquaculture in West Malaysia alone (Ang Kok Jee, personal communication).

Tilapia (*Tilapia mossambica*) is a freshwater fish, first introduced from Africa during the colonial era. This fish is widely found in Malaysian freshwater bodies. It is a hardy fish with a vigorous breeding capacity and, in some freshwater fish farms, it is considered a pest because it competes for food with higher-valued species. In Malaysia the consumption of tilapia is insignificant and there is no known commercial utilization of the fish.

This paper discusses four products developed, from tilapia, at the Department of Food Science and Technology, Universiti Pertanian Malaysia: fish sauce, 'pekasam' (fermented fish), canned tilapia and dried salted tilapia.

FISH SAUCE

Fish sauce is consumed in South-East Asia by approximately 250 million people. It is known under different names in different countries; in Thailand and Lao it is called nampla; in Democratic Kampuchea and Viet Nam, nuoc-mam; in the Philippines, patis; in Indonesia, kicap ikan; in Malaysia, budu and in Burma, ngapi. In Thailand, Viet Nam and Democratic Kampuchea, fish sauce production is the biggest fisheries industry (Saisithi *et al.*, 1966).

Consumption of fish sauce is high in the states on the east coast of West Malaysia; lesser quantities are consumed in other states. It is consumed as a condiment; a dip for vegetables, fish and meat; cooked as tumis and used as a gravy or to flavour other dishes. Consumption of fish sauce and other fermented fish products is more significant amongst the poor as it may be the only consistent source of animal protein during the monsoon season when most fresh foods, if available, are expensive.

Traditionally, fish sauce is prepared by mixing small fish of *Stolephorus* spp. (ikan bilis) with 25-33 percent salt and leaving them in a concrete tank or earthenware jars at ambient temperature for 6 months to 1 year. The product is then boiled, decanted and bottled. Some processors flavour the fish sauce with coconut, sugar, tomatoes, tamarind and chillies.

Attempts to speed up the rate of fermentation have not been made in Malaysia except by grinding the fish prior to salting. Amano (1962) discussed several accelerated processes including the addition of enzymes and acid, and raising the temperature.

The use of either enzymes or acid to speed up the rate of fermentation is unsuitable for the domestic production of fish sauce in Malaysia. Pure enzymes are expensive and sometimes not available in most villages though there is a possibility of using crude enzymes from papaya or pineapple. Hydrochloric acid is also expensive and could be very dangerous to handle (especially the fumes) for most village-scale processes. The flavour and aroma of an acid-hydrolyzed product is more similar to acidhydrolyzed soy sauce than to fish sauce. Certain amino acids, especially tryptophan, are destroyed during the hydrolysis.

Several fungi have been used in the production of various fermented foods. *Aspergillus oryzae* has been exploited for a long time in the production of soy sauce. This fungus produces various enzymes such as proteases, lipases and carbohydrases, which can be used in the production of fish sauce. The method of experimental production using tilapia is shown in Fig. 1.

Cleaned, polished rice is mixed with water (1:1 w/v), autoclaved at 121°C for 15 min and then allowed to cool to room temperature. It is inoculated with *Aspergillus oryzae* NRRL 1989 and incubated at 30°C for 3 days. The rice, overgrown with *A. oryzae* is mixed with fish and water (1:1:1). Salt (15 percent) is added to the mixture and incubated at 40°C for 2-3 weeks. The liquid is filter-pressed, aged for 2-3 weeks and then flavoured. The sauce is bottled and pasteurized. It has a strong fish sauce aroma.

Fish sauce with a milder aroma can be made by incubating the mixture at 55°C. This is advantageous if it is to be used by a group of people more familiar with soy sauce than with fish sauce.

The proximate composition of tilapia is similar to that of anchovy, the fish used in the traditional fermentation of fish sauce (Table 1).

PEKASAM

Pekasam is consumed in Kelantan and Kedah, Malaysia. The product is prepared in a similar way to burong dalag in the Philippines (Fig 2). Pekasam is eaten with rice either fried or wrapped in banana leaves and roasted on charcoal or a wood fire. There are several methods of preparation, depending on locality. Studies on the microbiological and biochemical changes which occur during fermentation are limited. Our preliminary studies indicated a large increase in the number of micro-organisms, especially yeasts and lactic acid bacteria.

Table 1

Composition of tilapia and anchovy
(100 g edible portion)

	<i>Tilapia mossambica</i>	<i>Stolephorus</i> spp.
Food energy (cal)	106	99
Moisture (g)	77.4	76.9
Protein (g)	18.8	18.5
Fat (g)	2.8	2.2
Carbohydrates (g)	0	0
Ash (g)	1.0	2.4
Calcium (mg)	54	279
Phosphorus (mg)	172	264
Iron (mg)	0.4	1.2
Retinol (ug)	25	25
B-carotene (ug)	5	—
Thiamine (mg)	0.03	0.01
Riboflavin (mg)	0.12	0.08
Niacin (mg)	3.1	3.5
Ascorbic acid	0	—

Source: Wood-Tsuen Wu Leung, 1972

Table 2

Ingredients in tomato sauce	%
Tomato puree	42
Water	35
Vegetable oil	20
Vinegar	1.5
White pepper	0.5
Sugar	0.5
Salt	0.5
pH	4.25

Figure 1

Preparation of fish sauce from tilapia
using *Aspergillus oryzae* NRRL 1989

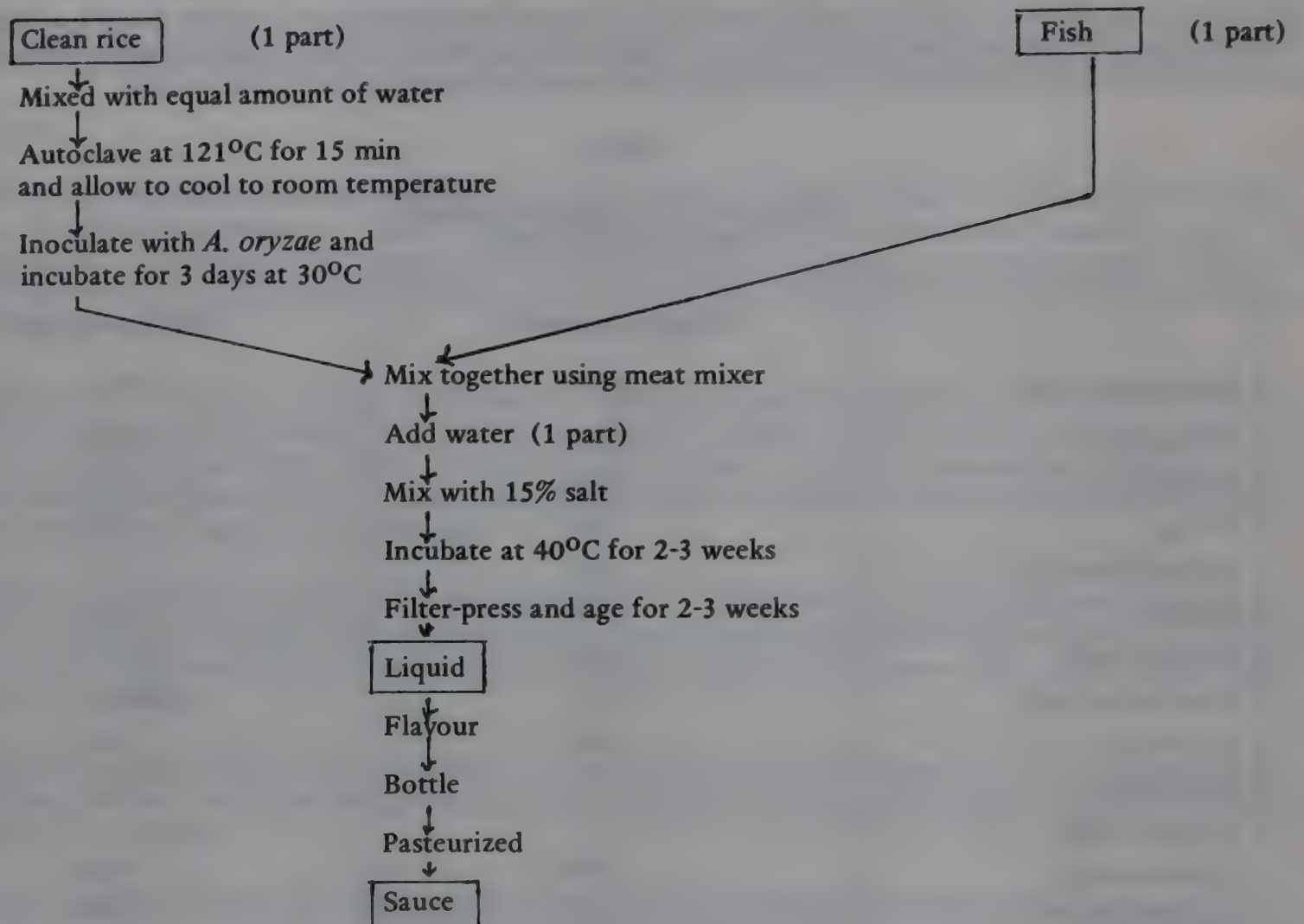


Figure 2

Preparation of Pekasam

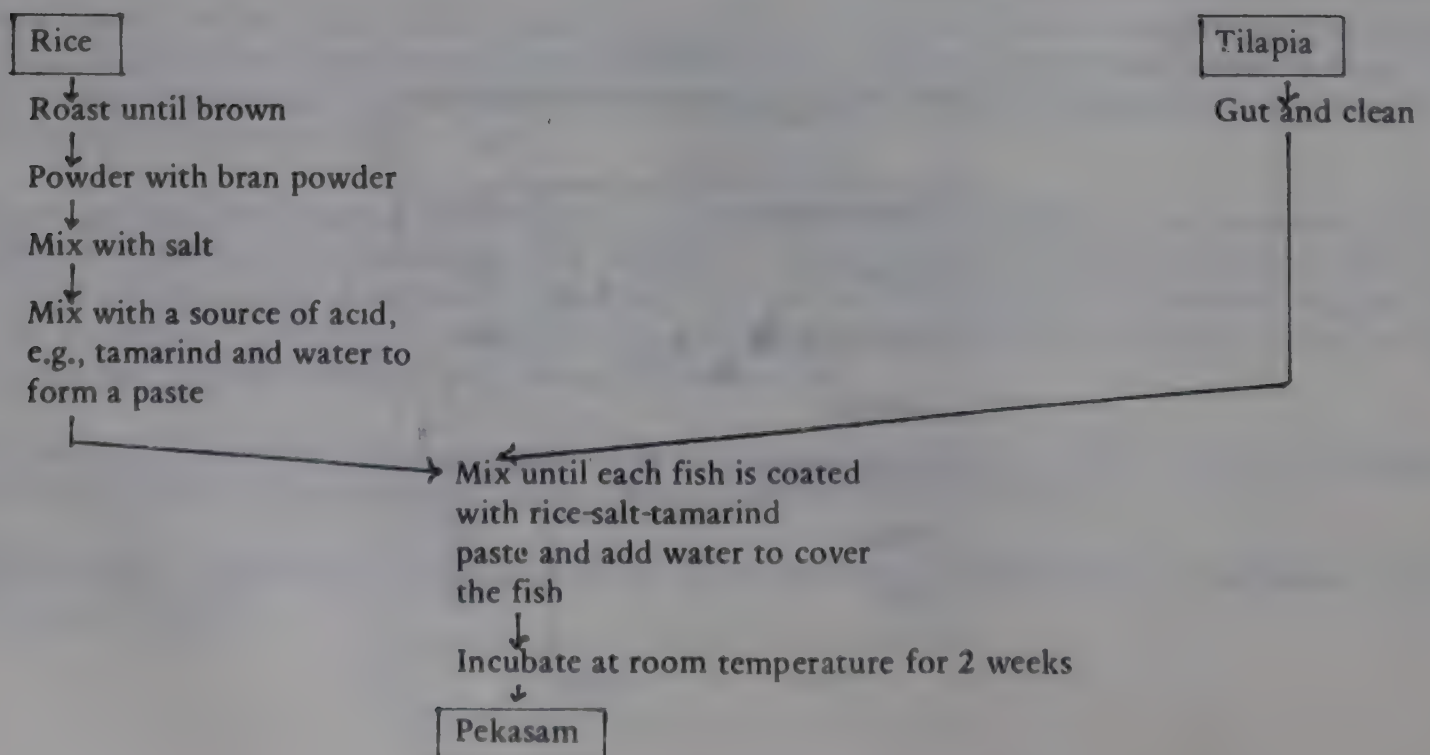


Figure 3

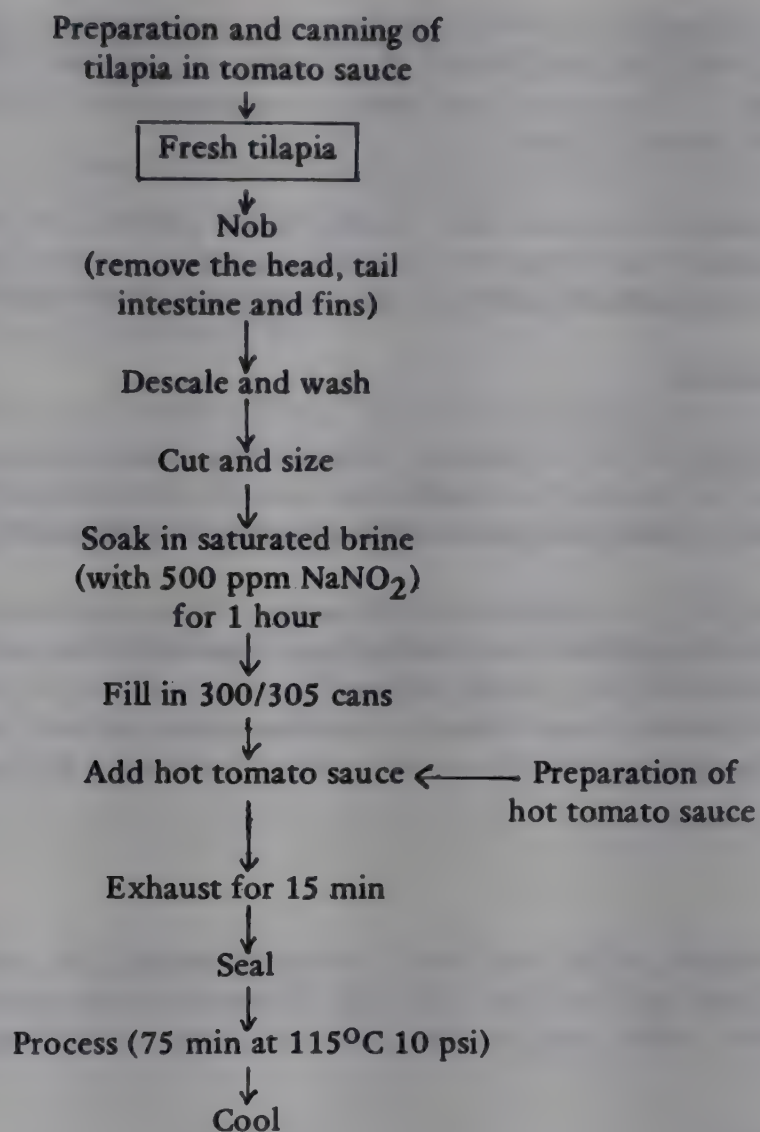
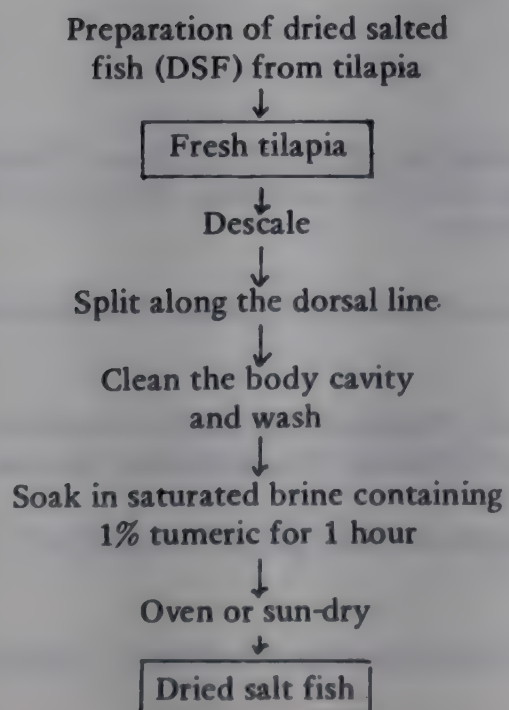


Figure 4



CANNED TILAPIA

Canned fish is a popular product in Malaysia. Its consumption is not limited by income level, race or religion. It can be eaten with rice, bread or roti canai (Malaysian pan cake). The method of canning tilapia in tomato sauce is shown in Fig. 3. The product was found to be acceptable to the Malaysian taste. The ingredients of the tomato sauce used are shown in Table 2.

Each can of tilapia in tomato sauce contained 60 percent fish and 40 percent sauce by weight. When evaluated, the appearance was comparable to the commercial canned fish available in the market. The product has no strong fishy or objectionable odour. It has a very good texture and flavour and an attractive colour.

DRIED SALTED TILAPIA

Salting and drying of fish is probably amongst the oldest methods of preserving fish in the tropics. In Malaysia, this method is still used to handle and preserve fish especially during seasonal gluts. It is considered an inexpensive method of fish preservation. Unlike canned fish, there are various grade of dried fish.

Dried salt fish (DSF) is consumed by all races at all income levels. The preparation of DSF from tilapia, at the Department of Food Science and Technology, was carried out as shown in Fig. 4. The dried salted tilapia has an attractive yellowish-brown colour, imparted by the addition of tumeric powder. It has a pleasant flavour when fried. Tumeric powder is used instead of sodium nitrite because tumeric is available locally and has been used by Malaysian housewives. With the controversies surrounding sodium nitrite, it is also advisable to look for an alternative.

CONCLUSION

These four products which have been developed should not face consumer acceptability problems in Malaysia as the products are not alien. The only difference is the species of fish used. Various other products may be developed from tilapia, such as fish balls, fish cakes and fish burgers, and various canned fish products to name a few.

ACKNOWLEDGEMENT

The authors wish to express many thanks to Dr. Idris Abdol from the Farm Division, Universiti Pertanian Malaysia for supplying the fish and the Vice-Chancellor of Universiti Pertanian Malaysia for making this paper possible.

REFERENCES

- Amano, K., The influence of fermentation on the nutritive value of fish with special reference to fermented fish products in Southeast Asia. *In* Fish in nutrition, edited by E. Heen and R. Kreuzer. London, Fishing News (Books) Ltd., pp. 180-200
1962
- Berg, A., The nutrition factor: its role in national development. Washington D.C., Brookings Institute
1973
- Berg, A., N.S. Scrimshaw and D.L. Calks, Nutrition, national development and planning. *In* Proceeding of International Conference Held at Cambridge, Massachusetts, October 19-21, Cambridge, Mass.
1971
- FAO, Population, food supply and agriculture development. Rome, FAO, 67 p.
1975
- Kallen, D.J., Malnutrition, learning and behavior. *Ecol. Food Nutr.*, 2:133-41
1973

- Kong, S.M., Short term and long term plans for interesting fish production. Kuala Lumpur, Director of Fisheries, 1964 Government of Malaysia pamphlet, Feb.
- Latham, M., Diet and infection in relation to malnutrition in the United States. *N.Y.State J.Med.*, 70:558-61
1970
- Latham, M. and F. Cobos, The effects of malnutrition on intellectual development and learning. *Am.J.Public Health*, 61:1307-24
1971
- Malik, U.A., An economic appraisal of fresh water fish development in Peninsular Malaysia. Kuala Lumpur, 1977 Malaysia Economic Association, 10 January 1977
- Saisithi, P. *et al.*, Microbiology and chemistry of fermented fish. *J.Food Sci.*, 31:105-10
1966
- Stillings, B.R., Nutritional evaluation of fish protein concentrate. *Activ.Rep.*, 19:109-17
1967
- Wurtman, R. and J.D. Fernstrom, Effects of diet on brain neurotransmitters. *Nutr.Rev.*, 32:193-9
1974

RADIATION DISINFESTATION STUDIES ON SUN-DRIED FISH

by

Mainuddin Ahmed, A.D. Bhuiya, A.M.S. Alam and S.M.S. Huda
Irradiation and Pest Control Research Institute (IPCORI)
Bangladesh Atomic Energy Commission
Dacca-2, Bangladesh

Abstract

The loss of a large quantity of dried fish in Bangladesh is due to infestation by earwigs, hide beetles and copra beetles in storage godowns. The most destructive pest is the hide beetle, *Dermestes maculatus* Degeer.

Earwigs of different stages of development were exposed to 10, 20 and 30 krad of gamma radiation for disinfestation. No live insects were seen 3 weeks after the treatment. Studies on dried mackerel infested with hide beetles showed that eggs, larvae and pupae could be checked at a dose of 20 krad. A dose of 30 krad killed all adults within 2 weeks.

In packaging studies, dried mackerel was packed in polythene pouches of different thicknesses. All irradiated treatments were free from insect damage while the controls were heavily damaged. However, all these treatments developed heavy fungal growth except the heat-treated control. In other experiments, pouches of 50, 75 and 100 μ thickness were exposed to 50, 100, 200 and 400 krad as in the previous experiment. In all the treatment, moisture content was reduced to 13 percent. Heavy insect damage was observed in the control but all other treatments were in excellent condition after 5 months' storage.

INTRODUCTION

Sun-dried, smoked, salted and dried fish are favourite foods in South East Asia. In Bangladesh freshwater fish is preferred; during peak periods, the surplus fish is sun-dried for off-season consumption. About 0.9 million tons of fish are caught annually in Bangladesh. Most of the marine fish (about 10 percent of the total) are dried.

Heavy losses of dried fish occur through pest infestation in two stages; (1) during drying, and (2) during storage in godowns and transportation. Fresh fish with a high moisture content is subject to heavy blow fly infestation (*Lucilia* sp.). In laboratory samples, *Drosophila* and house fly larvae have been found. It is understood that in the Philippines (Pablo, personal correspondence) fish is also infested with flies of the Sarcophagidae family. Fishermen have indicated that as much as 30 percent of the meat is lost due to fly infestation. There is very little done in practice to prevent flies from infesting the fish. Occasional spraying of insecticides is done very injudiciously with harmful results to consumers; in some cases, molasses sprinkled with insecticides are used as bait to kill the flies.

The real danger to sun-dried fish is beetles. They attack fish during transportation, in godowns and even at the consumer level. The most important pest in Bangladesh is the hide beetle, *Dermestes maculatus* Degeer. This species also occurs abundantly in Africa (Azab *et al.*, 1973; Osuji, 1975; Pointel and Pham Van Sam, 1969). The copra beetle, *Necrobia rufipes* Degeer, and earwigs are also associated with dried fish in Bangladesh. Pablo (personal correspondence) has noted the occurrence of *Dermestes carnivorus* in dried fish in the Philippines. Insecticides are seldom used in Bangladesh to control beetles. Cleanliness is maintained as much as possible but businessmen pay heavily due to beetle damage; as a result, there is a tremendous price fluctuation depending on the season.

LITERATURE REVIEW

A number of workers have conducted research on the biology and insecticidal control of insects in dried fish, but very few have reported on radiation disinfestation. Hinton (1955) reported that the hide beetle, *D. maculatus* Degeer is a pest of great economic importance which causes extensive damage to dried animal products such as hides and dried fish. Alam (1971) mentioned that *D. maculatus* Degeer causes serious damage to dried fish in this country. Paul *et al.*, (1963) studied the life history of the beetle at constant temperature and humidity. He reported the incubation, larval and pupal period at 30°C and 70 percent RH as 2.4, 8 and 7 days respectively. He also recorded a life span of 87 days in male and 98 days in females. Azab *et al.*, (1973) conducted a series of experiments to investigate the biology and factors affecting development, adult longevity and the rate of oviposition of *D. maculatus* Degeer at different temperatures. They found that the egg stage varied from 1-2 days at 30°C and 10-11 days at 16.8°C. The larval period lasted between 24 days at 32°C and 96 days at 19.4°C. The prepupal stage lasted 2-11 days according to temperature. The pupal stage averaged 5.1 days at 29.7°C and 33.1 days at 16.4 °C. Oviposition was also greatly affected (from 28-130 days) by the variation of temperature and humidity. Osuji (1975) studied the development of *D. maculatus* Degeer in dried fish under laboratory conditions; females laid eggs within 12 h of copulation and hatching occurred at about 48 h. After oviposition, larval development was completed in 33.5 days during which time several moults occurred. The adult emerged about 11 days after the last instar stage, irrespective of the mode of pupation.

Maclellan (1964) preserved dried fish for 6 weeks against insect attack by using a water emulsion containing 0.01 percent pyrethrin and 0.036 percent piperonylbutoxide. Lloyd and Dyte (1965) studied the susceptibility of *Dermestes* spp. to 15 contact insecticides. The organophosphorus compounds, dimethoate, morphothion, dicapthion, fenithrothion, fenthion, etc. were most effective in killing *Dermestes* spp. Dieldrin was the most effective compound used on *D. maculatus* Degeer but it yielded negligible mortalities with *Dermestes lardarius* and *Dermestes ater*.

Dyte *et al.* (1966) observed that with malathion the LD50 for larvae of *D. maculatus* Degeer was 10 times that for larvae of *D. lardarius*. However, these two species are known to have similar susceptibilities to several other organophosphorus insecticides. Kane (1967) reported that silica dusts of low bulk density showed promise for the control of *Dermestes frischii* Kug, *D. ater* Degeer and *Necrobia rufipes* Degeer infesting dried fish.

Green (1967) stated that control and subsequent protection could be achieved by dipping infested dried fish in an emulsion containing 0.02 percent pyrethrum or 0.0625 percent malathion. (1971) wheatly used several insecticides to evaluate the most promising compounds for the control of *Dermestes* spp. He placed the insecticides in order of effectiveness as dieldrin, carboxyl, Bayer 7788, Dursban and fenthion. Proctor (1972) reported that an emulsion containing 0.018 percent pyrethrin and 0.036 percent pyperonylbutoxide applied to smoke-dried fish in Zambia prevented infestation by *Dermestes* spp. for about 8-12 weeks. He concluded that a pyrethrin emulsion was economically feasible and suitable for use in Zambia. Levinson and Bashelkousky (1967) introduced antivitamins in the diet to control the hide beetle and had some success in arresting its development. Shaw and Lloyd (1969), on the other hand, reported that an Australian strain of *D. maculatus*, when exposed to r-BHC and reared for 15 generations on fish meal containing r-BHC, showed a gradual increase in resistance. This resistance reached 26 times that of the susceptible strain by the F14 generation. Toye (1970) found that heating dried fish in an oven at 60°C for 30 min at four-day intervals, in a simple charcoal-fired oven, and storage in metal containers would control the pests. Mushi and Chiang (1974) observed that dried fish containing 13 percent, or more, salt could prevent the growth of insects at all developmental stages.

Daget (1966) used ionizing radiation for the disinfestation of dried fish in sealed containers; this resulted in death or sterilization of the insects without any harmful effects to the products. Boisot and Gauzit (1966) reported that 30 percent by weight of the fish was destroyed by insect infestation and that none of the conventional methods of control was successful. They used various doses of radiation and the dose necessary for sterilization was estimated as between 15 000 and 40 000 rad; no organoleptic changes were observed at 50 000 rad. They also studied the taste and nutritional value of the dried and smoked fish after exposing them to radiation

doses ranging from 20 000 to 50 000 rad; no adverse effects were reported. Pointel and Pham Van Sam (1969) used irradiation with doses from 10 to 30 krad to find out the sterilization dose for *D. maculatus* Degeer. None of the treated stages gave any progeny and their life span was shortened.

DISINFESTATION OF GONIA, CARP AGAINST EARWIGS

Earwigs are also a problem in dried fish and it was decided to establish the effects of irradiation treatment on dried gonia (*Labeo gonius*). With some difficulty a mixed population of these insects was built up in the fish and no attempt was made to separate earwigs into age groups. The fish were exposed to gamma rays from a cobalt 60 source at doses of 10, 20 and 30 krad. Each sample had about 50 g of dried fish and each treatment was replicated four times. After 12 days, the number of insects, both dead and alive, were counted (Table 1). There was considerable damage in the controls but almost none in any of the irradiated samples. The number of dead insects in the control was significantly fewer than in other treatments; live insects were found only in the controls. It can be seen that the fish were completely disinfested by these doses of radiation. Further observations were made after another 3 weeks but there were no live insects and none of the samples was damaged.

Table 1

Effect of irradiation on earwigs associated with dried fish, *Labeo gonius*

Sample no.	Irradiation dose (krad) (number of dead larvae)			
	0	10	20	30
1	2(10)*	4	9	9
2	2 (5)	8	8	6
3	4 (4)	5	6	12
4	3 (7)	7	8	7
Average	2.75 ^a **	6.0 ^b	7.75 ^b	8.50 ^b

* Number in parentheses = number of alive larvae

** Number designated by unlike letters are significant

Least significant difference between treatments (LSD) at 5% level = 3.09

Least significant difference between treatments (LSD) at 1% level = 4.75

DISINFESTATION OF DRIED MACKEREL

Mackerel is an important fish in the Bay of Bengal. It is estimated that about 15 percent of a total catch of 80 000 tons of marine fish is mackerel, most of which is dried. It is one of the most expensive dried fish. Experiments were conducted to determine the disinfesting dose for eggs, larvae, pupae and adults of the hide beetle, *D. maculatus* Degeer; each treatment was replicated five times.

Materials and methods

Laboratory-reared insects, grown on mackerel, were used for all the experiments. Dried mackerel were heated in an oven for 24 h at 50°C. For convenience, Petri dishes (9 cm diameter) and small insect-rearing jars (5 x 8 x 15 cm) were used to maintain the experimental insect population. The Petri dishes were covered with tissue paper for aeration before replacing the lid; rearing jars were covered with muslin which was secured with rubber bands.

Eggs

Hide beetles lay eggs in crevices and stick them to dried fish. When the eggs were separated from their substratum, a large number became damaged. Therefore, an indirect method was used for the irradiation of eggs. Adults were released on dried mackerel and after 48 h, 40 g of dried fish were taken for each replicate. The dried fish with eggs (0-48 hour old) were exposed to 0 (control), 2.5, 5, 7.5, 10 and 15 krad of gamma rays.

Larvae

Last instar larvae were separated from stock cultures; these were 25-28 days old and a few had started to pupate. Fifty grammes of dried mackerel were placed in a rearing jar and 20 larvae were added. These were irradiated at 0, 2.5, 5, 7.5, 10, 15 and 20 krad. Observations were made every other day for mortality and feeding. Fresh food, which was irradiated at the same time as the larvae, was added only when necessary.

Pupae

The pupae selected for irradiation were 2-4 days old; 20 pupae were added to 50 g of dried fish. The samples were exposed to 0, 5, 10, 15 and 20 krad and then the pupae were placed in Petri dishes. Daily observations were made for mortality of pupae, adult emergence and adult mortality. As the adults emerged they were transferred to small rearing jars containing treated food.

Adults

Adults, 6-7 days old, were set up similarly and were exposed to 0, 5, 10, 15, 20, 30 and 40 krad. The irradiated adults were housed in rearing jars and observations were made on alternate days for feeding, mortality and production of F_1 progeny if any.

Sterility doses

The pupae were separated from the rearing media and each was placed in a separate vial to ensure emergence of unmated adults. Males of 2-3 days old were exposed to 1, 1.5, 5 and 10 krad of gamma radiation. After treatment, 5 males were combined with 5 females in rearing jars (15 x 8 x 5 cm) to determine the doses for sterility.

Results

Eggs

The observations were made after 10 days; the fish were broken up carefully and the number of larvae either dead or alive was counted (Table 2). All the larvae in the treated samples were dead, although there were some cast skins. There was normal feeding in the controls, whereas feeding (as determined from the damaged fish) was reduced increasingly with increased radiation doses. At the time of observation, all larvae in the controls were second and third instars; larvae in the treated samples died in first and second instars. This was established by the number of cast skins, which at 2.5, 5, 7, 10 and 15 krad, were 21.4, 16.6, 10.2, 4.8 and 3.4 respectively compared to 40 in the control.

Table 2

Effect of irradiation on 0 to 48-h old eggs of *Dermestes maculatus* Degeer
10 days after treatment

Sample no.	Irradiation dose (krad) (number larvae dead or alive)					
	0*	2.5	5	7.5	10	15
1	20	45	46	10	15	24
2	30	36	36	17	5	10
3	25	27	70	75	31	27
4	62	33	41	22	15	10
5	17	60	55	32	20	12
Average	30.8	40.24	49.6	31.24	17.24	16.6

* All larvae in control were alive; none was alive in the irradiated groups

Larvae

Results of larval mortality are shown in Table 3 and Fig. 1. Larvae are susceptible to irradiation; a dose as low as 5 krad gave 90 percent mortality compared to 26 percent in the control. The number of dead larvae was highly significant in treated insects compared to the control. Feeding after a dose of 10 krad and above almost stopped. Fig. 1 also shows that there was a peak of mortality on the eighth day after treatment. Although the insects exposed to the higher doses continued to live, they were moribund and could be considered as dead. None of the irradiated insects pupated. Pupation was 74 percent in the controls and the adults which emerged subsequently produced normal F_1 progeny.

Table 3

Effect of irradiation on last instar larvae of *D. maculatus* 20 days after treatment

Sample no.	Irradiation dose (krad) (number of dead larvae)						
	0	2.5	5	7.5	10	15	20
1	8	16	18	8	15	18	20
2	5	16	19	18	20	10	19
3	2	20	18	18	19	20	20
4	6	18	17	20	9	19	20
5	5	12	18	20	16	20	20
Average	5.2 ^a *	16.4 ^b	18.0 ^b	16.8 ^b	15.8 ^b	17.4 ^b	19.8 ^b

* Numbers designated by unlike letters are significant

LSD at 5% level = 4.21

LSD at 1% level = 6.12

Pupae

Radiation effects on pupae are summarized in Table 4; unlike larvae, irradiation did not drastically check adult emergence. Emergence of adults was 89 percent in the control and 72 percent in those exposed to 20 krad. The percentages of deformed adults from pupae treated at 0, 5, 10, 15 and 20 krad were 0, 17, 32, 21 and 36 respectively. There was a significant difference between the highest and the lowest irradiated treatment. All adults at 20 krad were deformed. Normal adults from irradiated pupae were allowed to mate but no progeny was obtained. Control adults produced normal progeny.

Adults

Mortalities in adults were recorded for 24 days. Dose response curves are shown in Fig. 2; it is evident that radiation drastically affected the longevity of adults. There are two peaks: the first was due to higher doses of radiation and the second to lower doses of radiation. Table 5 shows that after 14 days, over 90 percent mortality was obtained at a dose of 15 krad compared to 18 percent in the controls. Insects at 5 and 10 krad initially showed normal feeding but, afterwards, feeding was much reduced; adults at doses of 15 and 20 krad showed little feeding from the very beginning. Adults subjected to 30 and 40 krad seemed to get a shock after irradiation but recovered after a couple of days. Feeding was almost stopped at 30 krad and there was no sign of feeding at 40 krad. However, at higher doses, movement of insects was greatly affected. They continued to live although moribund. Control insects were all normal.

Sterility doses

It was observed that 50 percent sterility could be induced in males by a dose of 1 krad. A dose of 5 krad could be considered an effective dose for inducing almost 100 percent sterility.

Table 4

Effect of irradiation on 2-4 day-old pupae of *D. maculatus*

Irradiation dose (krad)	Number of adults emerged	Number of adults deformed	Number of adults dead after 20 days
Control	17.8	0	2.4 ^a
5	14.24	3.4 ^{a*}	13.6 ^b
10	15.00	6.4 ^{bc}	14.4 ^b
15	11.8	4.24 ^{ab}	11.8 ^b
20	14.40	7.24 ^c	14.40 ^b
LSD 5%	3.43	2.34	4.21
LSD 1%	5.03	3.43	6.12

Numbers designated by unlike letters are significant

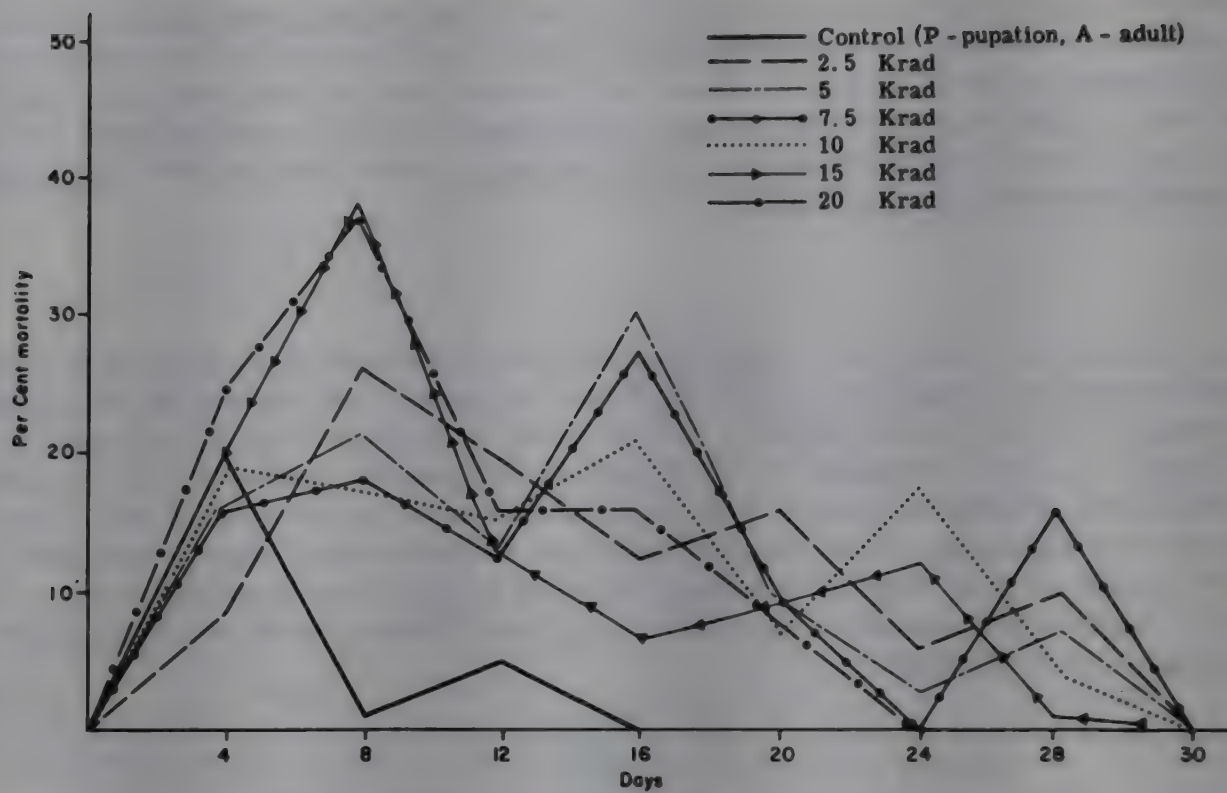


Figure 1 — Mortality of the last instar larvae of *Dermestes maculatus* after being exposed to gamma-rays

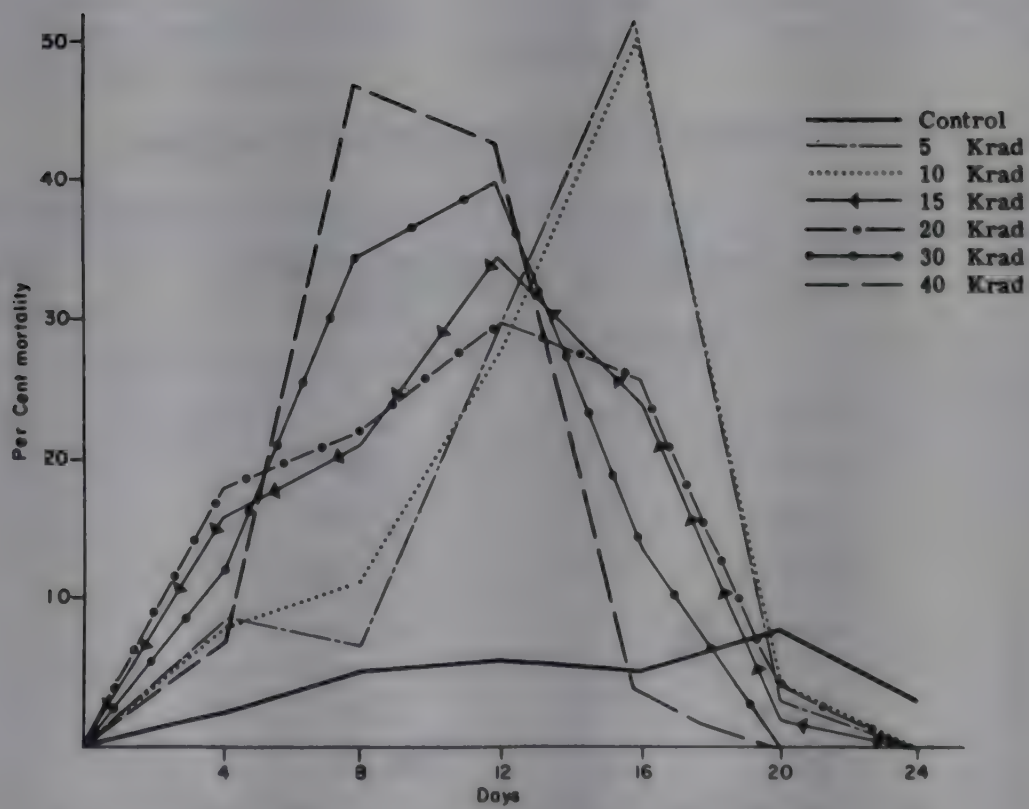


Figure 2 — Mortality of the adults of *D. maculatus* after exposure to gamma-rays

Table 5

Percentage mortality of irradiated 6-7 day-old adults of *D. maculatus*
14 days after treatment

Sample no.	Irradiation dose (krad)						
	0	5	10	15	20	30	40
1	25	65	85	100	95	95	100
2	0	80	75	85	90	100	100
3	15	95	90	90	85	100	100
4	30	85	75	90	90	100	100
5	20	65	60	95	85	95	100
Average	18 ^{a*}	78 ^b	77 ^b	92 ^{cd}	89 ^c	98 ^{cd}	100 ^d

* Numbers designated by unlike letters are significant

LSD at 5% level = 9.96

LSD at 1% level = 14.47

PACKAGING STUDIES ON DRIED FISH

Materials and methods

Dried mackerel infested with large numbers of insects were used for this experiment but, to ensure heavy infestation, a number of insects in different developmental stages were added to the dried fish and left for 48 h. Some fish were also heated in an oven for 48 h at 60°C. Samples of 250 g were packed in polythene pouches, 25 x 16 cm, and sealed.

Two controls were used; (1) untreated control and (2) heat-treated control. Visual examinations were made for insect damage, insect mortality, development of mould and the condition of the polythene pouches, particularly insect punctures. The following experiments were carried out:

Experiment 1

The pouches (50 μ thick) were exposed to 10, 20, 50 and 100 krad of gamma rays; two controls were also maintained. The moisture content of the heated control was 13 percent; all the other samples contained 18 percent. All pouches were maintained in an incubator at $29 \pm 1^\circ\text{C}$ and 70 ± 5 percent relative humidity. The experiment was replicated four times.

Experiment 2

The pouches (75 μ thick) were exposed to 50, 100, 200 and 400 krad with two controls as in Experiment 1. Moisture content in the heat-treated control was 13 percent; while the other samples had 20 percent moisture. The experiment was replicated five times.

Experiment 3

Dried mackerel was kept in an oven at about 60°C for 24 h. The moisture content was 13 percent. Pouches were made from polythene of thickness 50, 75 and 100 u. The same doses of radiation were given as in the earlier experiment with similar controls. Five replicates for each thickness of polythene were made.

Results and observations

Experiment 1

In the untreated control samples normal feeding of insects continued. After 45 days, fungus started to develop in all but one replicate. After 65 days, all packages were completely spoiled due to the heavy growth of fungus and insect damage; living insects, in all developmental stages, were observed. Final observations were made at 100 days; a few insects were still alive and one package was punctured by insects. The heat-treated control was very good from the beginning. At the end of experiment no insect damage or fungal development was noticed in any of the pouches. The pouches were in excellent condition.

At 10 krad the condition of pouches was good up to 45 days with only slight insect damage. Very few living insects were seen and they were moribund. Slight development of mould was noticed after 65 days but all the insects were dead. In the final examination, after 100 days, 75 percent of the samples were totally spoiled due to mould; very slight insect feeding was noticed.

At 20 krad no apparent insect damage was noticed except in one pouch 65 days after treatment. Fungus had developed in all replicates after 45 days' storage but spoilage was considered moderate after 65 days of storage. At the end of the experiment, 50 percent of the product was totally spoiled due to fungal growth and slight insect damage was observed in one replicate.

At 50 krad treatment, the condition of the product was good for 65 days. No live insects were seen 15 days after the treatment and there was no insect damage in any of the replicates though the product had some indication of fungal development. After 100 days, 75 percent of the product was completely spoiled due to fungus. Condition of the packages however was very good; none was punctured by the pests.

Experiment 2

After 2 weeks insects in all developmental stages were present in the control. There were also *Necrobia rufipes*. No dead insects were found in the pouches. There was enormous feeding by the insects but no development of fungus and the pouches were not punctured. During the same period, dead insects were observed at 50, 100 and 200 krad with no development of fungus. Slight damage by insects was noticed in one replicate each at doses of 50 and 100 krad. The condition of 400 krad dose was very good; there was no indication of insect damage or fungal development. The pouches in all treatments were in good condition. The heat-treated control was similar to the 400 krad sample.

Development of mould was noticed in all treatments after 4 weeks and fungal development continued in all except the heat-treated control. The experiment was stopped at 90 days by which time the control was totally destroyed due to insect feeding and fungal development and a few insects, in developmental stages, were still alive. All other treatments, except the heat-treated control, had heavy fungal growth; it was noticed that 40-60 percent of the product was totally spoiled. However the heat-treated control was in very good condition with no insect puncture. Dead insects were found in all irradiated samples and species of *D. maculatus* Degeer and *N. rufipes* Degeer were present.

Experiment 3

Observations were made over 45 days. There was heavy insect damage in the control. No development of fungus or insect damage to the fish was noticed in any of the other treatments. Insects in the irradiated treatments appeared to be dead. The condition of the pouches was very good in all treatments except the control.

DISCUSSION

Disinfestation experiments with *Labeo goni* were successful. Although we could not establish whether earwigs were the primary pests in heavily infested godowns containing rejected dried fish, their presence contributed to the damage of fish. After one month of experiment, all earwigs disappeared indicating that such medium was not suitable for their growth.

Eggs of *D. maculatus* Degeer were most susceptible to radiation. Even the low dose of 2.5 krad prevented the eggs from developing into fully mature larvae. A dose of 5 krad controlled 90 percent of larvae within 2 weeks. Feeding was stopped at 10 krad and above; a dose higher than 10 krad should be used to control larval infestation. As there was no adult emergence in any of the treated larvae, further infestation could not occur.

Irradiation at the pupal stage did not check adult emergence even at lower doses (Table 4). There was no significant difference between treatments except between the control and 15 krad. It was observed that as the dose increased the percentage of deformities in adults also increased. All the adults which emerged from 20 krad were deformed. Normal adults from irradiated pupae were all sterile. Feeding of these adults was also drastically reduced; as such these could be considered harmless in the dried fish. From the dose response curves of Fig. 2, it appears that longevity of irradiated adults was much affected thereby curtailing their period of infestation. A dose of 15 krad killed 90 percent with 2 weeks; to check spoilage instantaneously, a dose of 30 krad was needed. It also appears that a dose of 20 krad could be considered for practical use as the feeding of adults in this treatment was very negligible.

It is apparent from these experiments and from other studies that earwigs and hide beetles can be eliminated by the use of gamma rays. The results of Daget (1966) Boisot and Gauzit (1966) and Pointel and Pham Van Sam (1969) agree with the present experiments. Beetles of all stages can be disinfested at 20-30 krad. This dose falls well within the permissible dose of radiation used in the disinfestation of cereals and cereal products in many countries.

From the three packaging experiments it was found that a dose of 50 krad and above would kill all insects. It was fungus which caused much of the spoilage of dried fish. In practice, jute bags are used for the transportation of dried fish. These bags allow the passage of air and the problem of mould growth is obviated. Quality of the heat-treated control remained very good. For the radiation doses as used in this experiment, the fish should be thoroughly dried for successful disinfestation.

All the thickness of polythene used were resistant to insects. There were however a few punctures in pouches of 50 μ thickness; 75 μ thickness would seem to be adequate for practical use. In Bangladesh polythene is considered to be a good packaging material since it is abundantly produced and readily available. It is also comparatively cheap.

ACKNOWLEDGEMENT

This study was partly supported by the International Atomic Energy Agency, Vienna under a Research Contract.

REFERENCES

- Alam, M.Z., Pests of stored grain and other stored products and their control. Dacca, Agricultural Information Service, 33 p.
1971
- Azab, A.K. *et al.*, The biology of *Dermestes maculatus* Degeer (Coleoptera, Dermestidae). *Bull.Soc.Entomol. Egypte*, 56:1-14
1973

- _____, Factors affecting development and adult longevity of *Dermestes maculatus* Degeer. *Bull.Soc.Entomol.Egypte*, 56:21-32
1973
- _____, Factors affecting the rate of oviposition in *Dermestes maculatus* Degeer. *Bull.Soc.Entomol.Egypte*,
1973a 56:49-59
- Boisot, M.H. and M. Gauzit, Disinfestation of African dried and smoked fish by means of irradiation. Application
1966 of food irradiation in developing countries. *Tech.Rep.Ser.IAEA*, (54):85-94
- Daget, J., Insect infestation of African dried or smoked fish and the possibility of its control by irradiation.
1966 Application of food irradiation in developing countries. *Tech.Rep.Ser.IAEA*, (54):73-83
- Dyte, C.E. *et al.*, Studies on the susceptibilities of the larvae of two hide beetles (*Dermestes* sp., Coleoptera) to
1966 malathion. *J.Stored Prod.Res.*, 1(3):223-34
- Green, A.A., The protection of dried sea-fish in South Arabia from infestation by *Dermestes frischii* Kug (Coleop-
1967 tera, Dermestidae). *J. Stored Prod. Res.*, 2(4):331-50.
- Hinton, H.E., Common insect pests of stored food products. London, British Museum (Natural History), 26-7
1955
- Kane, J., Silica-based dusts for the control of insects infesting dried sea-fish. *J.Stored Prod.Res.*, 2(3):251-5
1967
- Levinson, H.Z. and J. Baskelkousky, Nutritional effects of vitamin omission and anti-vitamin administration on
1967 development and longevity of the hide beetles, *Dermestes maculatus* Deg. (Coleoptera, Dermestidae).
J.Stored Prod.Res., 3:345-52
- Lloyd, C.J. and C.E. Dyte, The susceptibility of larvae of *Dermestes maculatus* Degeer (Coleoptera, Dermestidae)
1965 to some contact insecticides. *J.Stored Prod.Res.*, 1:59-67
- Maclellan, R.H., A pyrethrum dipping treatment to protect dried fish from beetle infestation. *Pyrethrum Post*,
1964 7(3):30-3
- Mushi, A.M. and H.C. Chiang, Laboratory observations on the effect of common salt on *Dermestes maculatus*
1974 Degeer (Coleoptera, Dermestidae) infesting dried, freshwater fish, *Roccus chrysops*. *J.Stored Prod. Res.*, 10(1):57-60
- Osuji, F.N.G., Some aspects of the biology of *Dermestes maculatus* Degeer (Coleoptera, Dermestidae) in dried
1975 fish. *J.Stored Prod.Res.*, 11:25-31

- Paul, C.F. *et al.*, A life history of the hide beetle, *Dermestes maculatus* Deg. (Coleoptera, Dermestidae). *Indian J. Entomol.*, 24:167-79
1963
- Pointel, J.G. and M. Pham Van Sam, Effects des radiations ionisantes sur le development de *Dermestes maculatus* Deg. *J.Stored Prod.Res.*, 5:95-109
1969
- Proctor, D.L., The protection of smoked dried freshwater fish from insect damage during storage in Zambia. *J.Stored Prod.Res.*, 8(2):139-49
1972
- Shaw, D.D. and C.J. Lloyd, Selection for Lindane resistance in *Dermestes maculatus* Deg. (Coleoptera, Dermestidae). *J.Stored Prod.Res.*, 5:69-72
1969
- Toye, S.A., Studies on the humidity and temperature reactions of *Dermestes maculatus* Degeer with reference to infestation in dried fish in Nigeria. *Bull.Entomol.Res.*, 60:23-31
1970
- Wheatley, P.E., Laboratory evaluation of insecticides for the control of *Dermestes maculatus* Degeer (Coleoptera, Dermestidae) on hides. *J.Stored Prod.Res.*, 7:304-7
1971

TECHNOLOGICAL DEVELOPMENT OF ARTIFICIAL AND SOLAR DRYING OF FISH IN INDIA

by

P.K. Chakraborty
Central Institute of Fisheries Technology
Cochin-682003, India

Abstract

This paper describes the design of a commercial tunnel drier operated by electricity (or steam) and a pilot solar drier for the dehydration of fish. The estimated costs of production of dehydrated fish are almost the same for both driers; in any drying operation the cost of energy is insignificant compared to the cost of the raw material. Commercial tunnel drying is not an expensive process and it can easily replace conventional sun-drying in India. In tropical countries, the solar drier may be regarded as the only scientific tool, within the reach of poor fishermen living in remote fishing villages, with which to dry their day's catch.

INTRODUCTION

Of the total marine catch of 1.3 million tonnes (1975) in India, only 5 percent is frozen and 21 percent is preserved by salt-curing and sun-drying^{1/} (Fig. 1). Broad categories of fish landings, as a percentage of the total marine catch, are shown in Fig. 2. With the exception of prawns and some of the table fish, most fish are preserved by traditional sun-drying. Although sun-drying has several drawbacks such as slow drying rate, product contamination and overall poor quality, it is widely practised, and has been throughout the ages, as there is no better method available to our fishermen to preserve their day's catch. One of the main reasons is that most fish are landed in remote fishing villages which are far from the consuming centres and which, in most cases, are not served by motorable roads. A good proportion of the catch will spoil and become unfit for consumption unless it is preserved by sun-drying.

In an attempt to improve the quality of the sun-dried product, the drying conditions, i.e., temperature, relative humidity and air velocity were controlled by artificial means. As a result, several artificial fish driers have been developed (Chakraborty 1975, 1976, 1977). Theory and design considerations of hot air driers have been elaborated by Van Arsdel (1963), Legendre (1961) and by the author (1975). Some pioneering work on artificial dehydration of fish in India was carried out by Prabhu *et al.* (1963) and Balachandran (1969); these workers standardized the drying conditions of some commercial fish. In this paper an attempt has been made to describe the design of tunnel and solar driers developed by the author and to assess their applicability to industry.

DESCRIPTION OF DRIERS

Commercial tunnel drier

The one-tonne capacity drier described in this paper consists of a long concrete tunnel (Fig. 3) divided into upper and lower chambers. In the upper chamber, two electric (or steam) heaters (75 kW), an air blower (275-283 m³/min) and several instruments, for controlling air temperature and humidity, are fitted; in the lower chamber, five trolleys of mild steel construction are moved on rails (Chakraborty, 1977). On the trolleys, several layers of perforated aluminium trays containing fish are arranged in the form of shelves. The production is scheduled that, when a trolley of finished product is moved out from one end of the tunnel, a trolley of fresh

1/ Source: CIFT and CMFRI, Cochin

fish is put in the line. Air movement is counter-current to the movement of trolleys for maximum efficiency, rate and quality of the product. In the lower chamber, two insulated doors are provided at both ends, and two exhaust fans, inspection doors and a central control panel are fitted on the longitudinal walls. The partition wall separating the upper and lower chamber does not extend to the full length of the tunnel; there are gaps at both ends for circulation of air. Air temperature is controlled by heaters which are regulated with bi-metallic thermostats and humidity is controlled by regulating the volume of recirculated dried air by wet bulb-responsive thermostatic control of the exhaust fan.

The body of the drier is made of 152 mm thick concrete (1:2:4) which gives adequate mechanical strength and insulation. The five trolleys are designed to carry 200 kg of fish. The aluminium trays are made of 18 SWG sheets. There is an elaborate rail system for shunting the trolleys from one end of the drier to the other end for their easy movement. An axial flow-type air blower, in the middle of the upper deck, is driven by a V-belt system from a motor situated on the roof of the drier. A 45 kW electric heater block is situated to the suction side and a 30 kW to the discharge side of the blower. A number of air inlet holes are provided on the wall above the trolley inlet door and the wall above the trolley discharge door is curved to deflect air from the upper to the lower chamber. On this curved wall the sensitive probes of the controlling instruments are fitted; there are two flexible tube dial thermometers (wet and dry bulb) and two bi-metallic or mercury in steel-type thermostats. The dry bulb thermostat controls the electric heater or, in case of steam heating, regulates the solenoid valve in the steam line. The other thermostat, operated on wet bulb temperature, controls the humidity by regulating the exhaust fan. The roof of the drier is covered with concrete slabs which can be removed for inspection and repair of installations in the upper deck. The drier is designed to operate over a wide range of temperature and humidity but, for normal fish drying, the following conditions were found to be optimum: air at 45 to 50°C, 60 to 65 per cent RH and 120 m/min velocity.

Solar drier

This experimental solar drier (Fig. 4) of 40 kg capacity was designed to study the possibility of solar drying of fish in tropical areas under hygienic conditions. The principle underlying the design is black body absorption for the collection of solar radiation heat coupled with continuous generation of hot air. The drier incorporates an air circulating system and drying tunnel for protecting the drying fish against contamination.

The solar heater for absorption of heat and heating of air is made by clamping two sheets of corrugated galvanized iron (GI) in 'crest-to-crest' position to form a number of channels along which air can flow. These sheets are clamped longitudinally to steel pipes. Collection and suction boxes are connected to their ends. Two ends of suction manifold boxes are opened for admitting fresh air and are provided with baffles and air filters for regulating the inflow of filtered air into the system, the collection manifolds are closed. Two hollow shafts are welded at the middle of each manifold to support the heater (on wooden bearings) which can be tilted manually toward the sun. The shaft fitted to the collection manifold is opened to the interior of the heater for collection of hot air via a polyethylene/rubber hose pipe to the suction mouth of an air blower, the other shaft being closed. There are three such heaters connected in parallel each having projected surface area of 3 m².

A centrifugal air blower, driven by an electric motor, is housed in a separate unit made of galvanized iron as shown in the figure. The long drying tunnel is made from GI sheet on a wooden/steel frame, with a square cross-section, and is connected to the discharge mouth of air blower while the other end of the tunnel is covered with insect-proof wire screen. In the tunnel, there are shelving arrangements for supporting perforated aluminium trays which are inserted through a central door.

The complete drier can be left out-of-doors under all weather conditions. It is painted black for maximum absorption of solar radiation and all joints are welded or cement-plastered to prevent leaks. Both the solar drier tunnel and heaters act as heat absorbers. The black body of the solar heater is heated to a higher temperature than the surroundings and acts as a heat exchanger between the cold atmospheric air and the hot metal body. The system is so designed that cold air is sucked inside the solar heater where it is evenly channelled and, as it passes along the tunnel, is heated to the desired temperature and subsequently blown over the fish. By proper

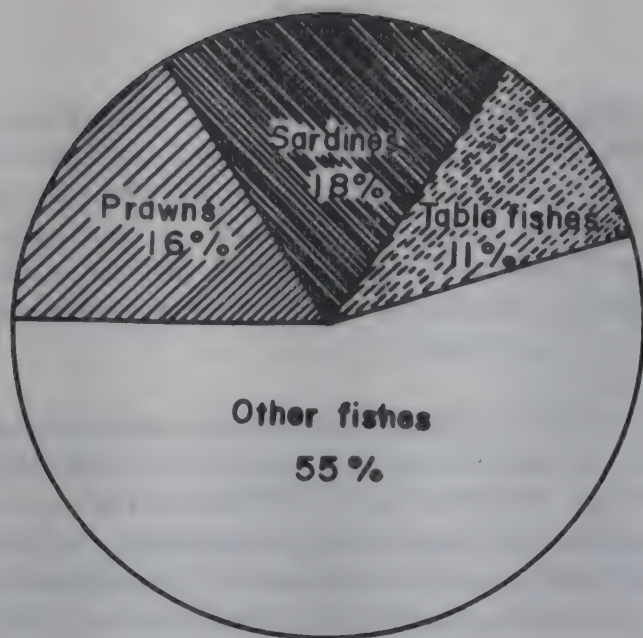


Fig. 1 — Fish landing in India (1975) as percentage of total landing of 1.3 million tonnes. **tage**

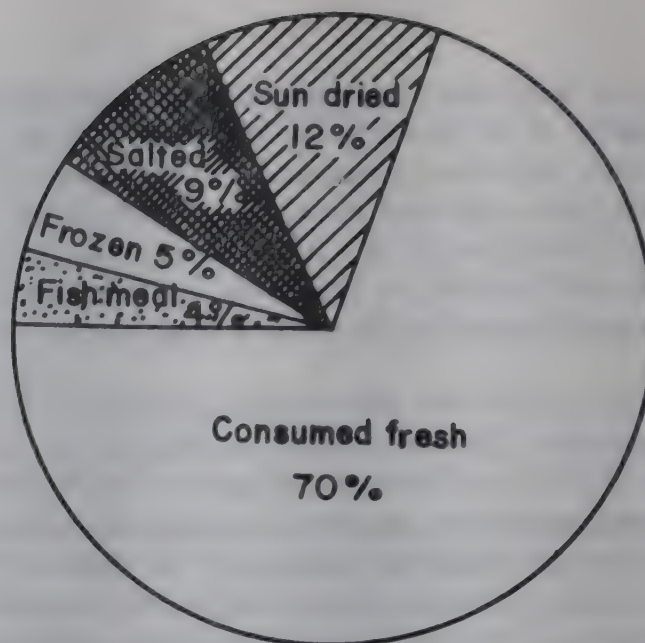


Fig. 2 — Fish utilization in India as percentage of total landing.

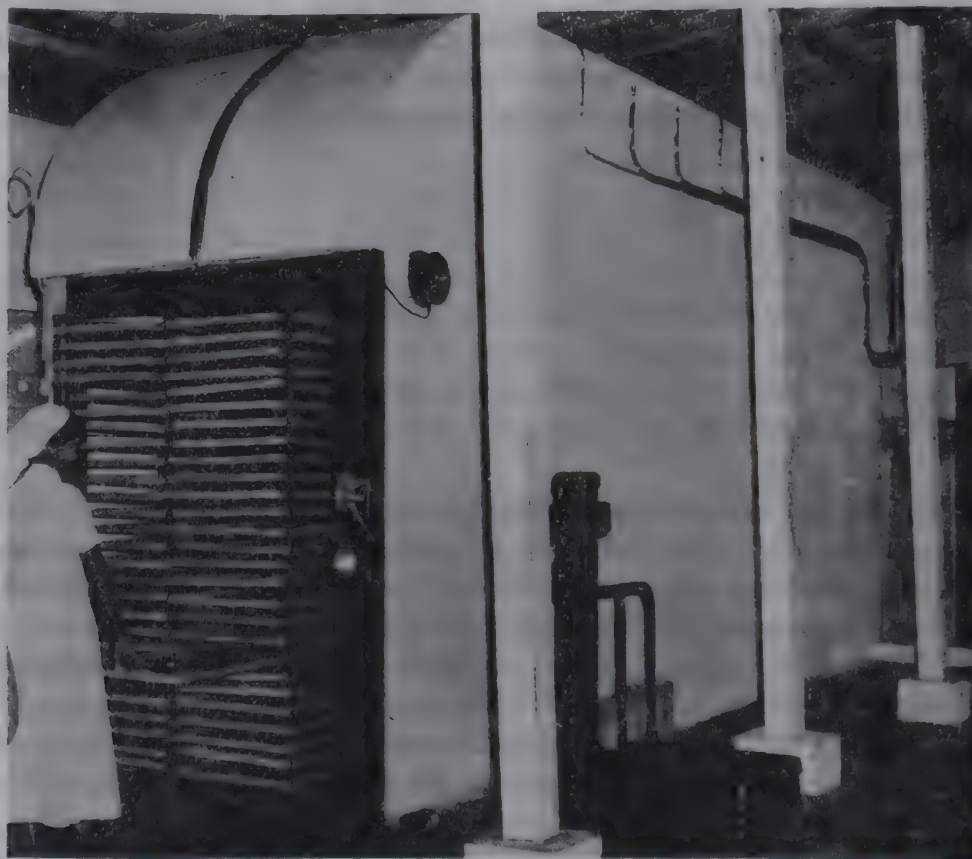


Fig. 3 — Commercial tunnel drier.



Fig. 4 — Solar drier.

adjustment of the material entering the door and the heat required for drying, a continuous hot air system has been developed. The drier recorded an average maximum temperature of 50°C at noon and an average minimum of 40°C on a normal sunny day of ambient temperature 30-32°C and wet bulb temperature 28-30°C. A drying potential, measured in terms of wet bulb depression, of 18-20°C has been achieved in this drier. Air velocity is kept at 120 m/min for maximum efficiency. Drying conditions obtained in the solar drier are similar to those of the tunnel drier described earlier.

PROCESSING OF FISH FOR DRYING

The raw material for the production of dehydrated fish is obtained from the by-catch of prawn trawling operations. Fish such as mackerel (*Rastrelliger kanagurta*), perches (*Nemipterus japonicus*), sprats (*Stolephorus* sp.), silverbellies (*Leiognathus* sp.), jew-fish (*Otolithus* sp.), *Lacterius lacterius*, shark, etc. are used. The preparation of the fish is the same for both tunnel and solar drying.

After initial washing, medium-size fish like mackerel, perches, jew-fish, etc. are split open longitudinally from the dorsal side along the backbone without removing heads, tails or scales but gills and viscera are removed. The fish are then washed again to remove slime, blood and dirt. The flesh is salted with common salt in the ratio of 1:5 (salt:fish) by placing alternate layers of fish and salt in the salting bath. After salting 18-24 h, the brine which forms is drained off and the fish are lightly washed to remove excess surface salt and the surface water is allowed to drain out.

The fish are spread on trays, inserted in the tunnel or solar drier and dried to a moisture level of 20-25 percent. Small fish are given a mild salt treatment by washing with brine to remove slime and dried to 15 percent moisture level while shark fillets are heavily salted (1:2) for 2-3 days to remove urea and dried to a 30-35 percent moisture level. Driers are operated at optimum conditions as described earlier. For medium size fish, drying time is 14-16 h in the tunnel drier and 13-15 daylight hours (2 days), for solar drying; normal sun drying takes double that time.

Dried products are packed in polyethylene bags as retail packs (1 kg, 500 g, 250 g) which are packed in cardboard cartons for despatch to interior markets or for export. Storage life of dehydrated fish is 6-9 months depending on storage conditions. One of the distinct features of the product produced in both these driers is its superior quality; it is completely free from the foul odours which are generally associated with a sun-dried product.

ESTIMATE OF THE ECONOMICS OF PRODUCTION

Amount in rupees (I.Rs. 1 = U.S.\$ 0.119)			
		<i>Tunnel drier</i> (Capacity:1 tonne)	<i>Solar drier</i> (Capacity:40 kg)
I.	<i>Total space requirement</i>		
(a)	Total land, 25 x 15 m, at Rs 10/m ²	3 750	
	(6 x 6 m)	—	360
(b)	Built-up area, 18 x 10 m, at Rs 250/m ²	45 000	—
	(Nil)	—	—
		48 750	360

II. *Machinery and equipment*

1.	One tonne tunnel drier complete with trolleys, heaters, blowers, etc. as per design	1	120 000	—
	(40 kg solar drier)	1	—	8 000
2.	Cement washing and salting tank lined with glazed tiles 1 m ³ at Rs 500 each	6	3 000	—
	(Buckets)	2	—	50
3.	Processing table 2.5 x 0.75 m with aluminium top at Rs 500 each	6	3 000	—
	(Nil)		—	—
4.	Platform balance 100 kg capacity	1	2 000	—
	Pan balance 1 kg at Rs 500	5	2 500	—
	(Salter balance: 2 kg)		—	100
5.	Well, water pumpset, overhead and underground tank, 200 l/days	1 set	4 000	—
	(Nil)		—	—
6.	Heat sealer for polyethylene bags	1	3 500	—
	(Hand sealer)		—	25
7.	Bucket, knives, tubs, etc.		2 500	25
8.	Contingencies		3 000	25
			143 500	8 225

III. *Recurring expenditure: 250 days/year*(a) *Raw material*1. *Lacterius*

1.2 tonnes/day x 250 = 300 tonnes/year
at Rs 3 000/t

900 000

—

(148 kg/day x 125 days = 6 tonnes x Rs 3 000)

—

18 000

2. *Salt*

60 tonnes/year at Rs 100/t

6 000

—

(1.25 tonnes/year)

—

120

(b) Electricity, water

1.	40 kW/h x 20 h x 250 days = 200 000 units at Rs 0.10/unit	20 000	—
	(0.5 kW/h x 250)	—	100
2.	Water	—	—

(c) Labour

1.	Plant manager at Rs 800/month	1	9 600	—
2.	Plant supervisor (Tech.) at Rs 600/month	2	14 400	—
3.	Male workers at workers Rs 10/day	4	10 000	—
4.	Female workers at Rs 8/day	21	—	500

(d)	Packaging material yield = 125 tonnes (2.5 tonnes) 250 000 (500) half kg packing at Rs 0, 10 for polyethylene bag and Rs 5 for 25 packs for master carton	75 000	1 500
-----	---	--------	-------

(e)	Wastage and contingencies	9 000	—
	(1 percent raw material)	—	180
		1 086 000	20 400

Summary**Fixed capital (Fc)**

(a)	Land and building	48 750	360
(b)	Machinery and equipment	143 500	8 225
		192 250	8 585

Working capital (Wc)

(Assuming 50 percent of recurring expenditure)	543 200	10 200
	543 200	10 200

Overhead

Depreciation of building at 5 percent	2 250	—
Depreciation of machinery at 10 percent	14 350	822.50
Interest on locked-up capital at 15 percent (Fc and Wc)	110 317	2 817.75
	126 917	3 640.25
		3 640 (say)

$$\text{Cost of production (tunnel)} = \frac{1\,086\,000 + 126\,917}{125} = \text{Rs } 9\,703.3$$

$$= 9.71/\text{kg}$$

$$\text{Cost of production (solar)} = \frac{20\,400 + 3\,640}{2.5} = \text{Rs } 9\,616$$

$$= 9.62/\text{kg}$$

In order to assess the economic viability of the tunnel drying and solar drying, the various components of cost have been analysed as a percentage of the total cost of production as shown in Table 1.

Table 1

Economic comparison of tunnel and solar drying

Cost component	Tunnel drying (%)	Solar drying (%)
Land and building	4.02	1.50
Machinery and equipment	11.83	34.16
Power and fuel ^{1/}	1.65	0.42
Material and labour	87.89	84.31
Overhead ^{1/}	10.46	15.27
Overall cost of production Rs/kg	9.71	9.62

1/ Recurring costs

CONCLUSION

Both the solar and tunnel drying processes are considered to be superior to conventional sun-drying, particularly in respect of quality of product. While tunnel drying is a fully artificial process, independent of weather conditions, solar drying may be considered a scientific method of sun-drying but is fully dependent on the availability of solar radiation. For the tunnel drier, considerable amounts of electrical or thermal energy are required whereas for the solar drier, the main energy requirement is obtained from the sun which is freely available in tropical countries. Another consideration is the shorter drying time compared to conventional sun-drying.

From Table 1 it may be seen that the cost of production per kilogramme of dry fish is almost the same in both cases. Although solar energy is free, the energy costs are insignificant in the total cost of production but the solar drying unit is more expensive than a thermal drying unit. It may be said that tunnel drying is not an expensive process and it can easily replace conventional sun-drying. The major element of cost in any drying operation is the cost of the material.

Solar driers may be applied successfully in tropical countries for the production of dehydrated fish as small-scale cottage units operated by individual fishermen. Large-scale commercial tunnel drying is economically feasible wherever power is available. These two types of non-traditional drying of fish have already made a beginning in our country and may be successfully applied in other tropical countries.

ACKNOWLEDGEMENT

The author is grateful to Shri G.K. Kuriyan, Director, CIFT, for his keen interest in the development and commercial application of these driers and his permission for publishing this paper.

REFERENCES

- Balachandran, K.K., An accelerated method of hot air drying of fish. *Fish Technol. Soc. Fish. Technol., Ernakulam*, 1969 6(2):124-8
- Balachandran, K.K. and A.N. Bose, Dehydration of prawns in tunnel drier. *Fish Technol. Soc. Fish. Technol., Ernakulam*, 1965 2(1):126-30
- Bhide, V.G., Pathways to solar energy utilization. *Invent. Intell.*, 9(7/8):255-68
1974
- Borgstrom, G., Fish as food. New York, Academic Press
1965
- Chakraborty, P.K., Multi-deck tunnel drier—a new concept in hot air dehydration of fishery products. *In Proceedings of the Symposium on fish processing industry in India. Mysore, 13-14 February 1975. CFTI*, 1975 pp. 144-7
- _____, Artificial dehydration in seafood industry. *Seafood Export J.*, 7(6):9-16
1975a
- _____, Solar drier for drying fish and fishery products. *Res. Ind., New Delhi*, 21(3):192-4
1976
- _____, Design of commercial dehydration plant and economics of production. *In Proceedings of the Conference on handling, processing and marketing of tropical fish. London, Tropical Products Institute*, 1977 pp. 331-6
- Dutta, R.L., Solar energy: its relevance to India. *Invent. Intell.*, 9(7/8):275-82
1974
- Kandoran, M.K., Fish in nutrition and economy. *Seafood Export J.*, 8(4):23-7
1976
- Khan, D., Sunshine is the fuel of the future. *Invent. Intell.*, 9(7/8):239-44
1974
- Khanna, M.L., Development of a prototype solar water heater. *Res. Ind., New Delhi*, 11:145-7
1966
- Legendre, R., The artificial drying of light salted cod fish. *J. Fish. Res. Board Can.*, 12(1):68-74
1955
- _____, Artificial drying of Cambodian fish. *J. Fish. Res. Board Can.*, 18(1):147-62
1961
- Prabhu, P.V. *et al.*, Investigations on dehydration of some commercial fish in India. *IPFC Curr. Aff. Bull.*, (37)
1963
- Van Ardsel, W.B. and J.M. Copeley, Food dehydration. Connecticut, AVI Publishing Co., 2 vols.
1963

QUALITY CHANGES IN FISH FROM THE SOUTH CHINA SEA: FROZEN STORAGE OF CHUB MACKEREL

by

R.G. Poulter
Tropical Products Institute
London, U.K.

Abstract

The keeping quality of frozen chub mackerel (*Rastrelliger brachysoma* Bleeker), a common and commercially important fish species in the IPFC region, was investigated. Organoleptic assessment indicated that, at -10°C , the fish remained in prime condition for 3 months and were acceptable for a further 9 months. Stored at -30°C the quality of the fish was maintained at a high level for at least 12 months. The rate of freezing was found to have no significant effect on acceptability. Unlike temperate mackerel species, little protein denaturation occurred in the samples stored at either temperature. Measurement of peroxide values indicated that deterioration of the lipids is probably the most important factor affecting keeping quality.

INTRODUCTION

One of the problems in exploiting pelagic fish is the seasonal nature of the fish stocks. For some of the higher valued species, freezing is one means of levelling out the fluctuations in supply. However, pelagic fatty fish generally have a shorter frozen storage life than the leaner demersal fish and, in the past, this has discouraged the practice of freezing as a method of preservation. Recently, a number of investigations have been made into methods of preserving the quality of pelagic fish during freezing and frozen storage and, in particular, into the mechanism of oxidative rancidity in these fish (Wu and Toyomizu, 1973; Trofimchuk and Pervuninskaya, 1974; Ke *et al.*, 1976). The latter authors concluded that the initial quality of frozen mackerel (*Scomber scombrus*) could be much improved by adopting techniques such as the use of refrigerated sea water and that the initial good quality could be preserved for at least 6 months by storing at temperatures of -26 or -30°C .

As in many other fields of fish technology, most of the published data on frozen fish are for cold- and temperate-water species. However, frozen fish has become an important commodity in the domestic market in a number of developing tropical countries during the last 15 years or so. Furthermore it is likely to increase in importance since it seems that, in many cases, the distribution costs for frozen fish may compare favourably with those for large-scale distribution of iced fish (Krone, 1977).

Published studies on frozen tropical pelagic species include Indian oil sardines (Shenoy and Pillai, 1971), Bombay duck (Radhakrishnam *et al.*, 1973), spotted seerfish (Shenoy, 1976) and chub mackerel (Bose, 1969; Keay *et al.*, 1972; Tarragool *et al.*, 1972; Nair *et al.*, 1976). Bose (1969) studies the keeping quality of 8 pelagic fish of commercial importance in India. The shelf-life varied between 6 to 20 months depending on initial freshness, method of packaging, mode of freezing and storage temperature.

The Tropical Products Institute is undertaking a systematic study, with standardized processing and analytical techniques, to determine the relative frozen storage stability of different tropical fish species and to see how they compare with temperate- and cold-water species. The findings of this project may allow more economic freezing and frozen storage conditions to be adopted in commercial practice.

In the present study, the first of the series, the keeping quality of quick- and slow-frozen samples of chub mackerel (*Rastrelliger brachysoma* Bleeker) was determined during storage at -30 and -10°C . A temperature of -30°C was chosen since this is the recommended storage temperature for frozen fish (Torry Research Station, Aberdeen, Scotland; Advisory Note, number 28). At this temperature, some of the cold store changes may take

several years to run to completion; in order to determine the total extent of cold store damage within a reasonable storage period, the changes occurring in fish stored at -10°C were also examined.

Materials

Chub mackerel (*Rastrelliger brachysoma* Bleeker) were caught by gill-net off Brunei in February 1976 and were placed in ice as soon as possible after capture. The fish were re-iced on landing by the Brunei Fisheries Department and sent by air freight to London. On arrival at the Tropical Products Institute in London (three days after capture) half of the fish were quick-frozen to -30°C in an air blast freezer and the other half were slow-frozen in a still air cold room at -10°C . Samples of both quick- and slow-frozen fish were sealed in plastic bags and stored at -10 and -30°C . At regular intervals over a period of one year, five fish from each treatment were removed and thawed at room temperature; two were used for organoleptic assessment and the remaining three for analytical tests. To obtain a homogenous sample for analysis, the fish were filleted and the white muscle removed leaving as much possible of the dark muscle and collective tissue. The white muscle was finely chopped using a scalpel and scissors and maintained at 0°C until required.

METHODS

Crude protein and non-protein nitrogen (NPN) content

These were determined on 2 g samples of fish muscle using the micro-Kjeldahl method (Bradstreet, 1965). Crude protein content was obtained by multiplying total nitrogen content by a factor of 6.25 (Pearson, 1970). For NPN determination, protein nitrogen was precipitated using 10 percent trichloro-acetic acid.

Total lipid and peroxide values

The lipids contained in 20 g of flesh were extracted by the Bligh and Dyer method (1959) using methanol and chloroform. The peroxide content of the extracted lipids was determined using potassium iodide and thio-sulphate (AOAC, 1965) and expressed as milli equivalents/kg lipid.

Water content

Approximately 10 g portions of fish muscle were placed in a convection oven maintained at 105°C and heated for 12 hours. The weight loss was presumed to be entirely due to evaporation of water.

Ash

Fish muscle (3 g) was placed in a silica dish and charred using a bunsen burner. The charred sample was ashed in a muffle furnace at 525°C .

Total volatile bases (TVB)

Perchloric acid extracts were prepared from duplicate 3 g samples of fish muscle (Jones *et al.*, 1965). The TVB contents were estimated by a procedure based on the microdiffusion method of Conway (Beatty and Gibbons, 1937) using sulphuric acid to absorb the liberated bases.

Hypoxanthine

Duplicate samples of fish muscle (2 g) were extracted with 20 cm^3 of perchloric acid and the hypoxanthine content of the extracts was estimated using the TLC method of Norman *et al.* (1974).

pH

Fish muscle (2 g) was homogenized in 10 cm³ of neutralized 0.005 M iodoacetic acid. The pH was measured at room temperature with a Radiometer 26 pH meter using a glass electrode. Each determination was performed in duplicate.

Taste panel

Portions of skinless fillets, approximately 25 g, were sealed in nylon pouches and cooked in boiling water for 30 minutes. A taste panel consisting of 4-6 experienced judges graded the samples from 1 to 10 for texture, flavour and overall score; 10 being good, 1 being bad, 4 being just acceptable.

Protein solubility

In frozen fish, the solubility of the muscle proteins in a solution of 5 percent NaCl has been widely used as a measure of cold storage protein denaturation (Connell, 1968). In this study, a solution of 5 percent NaCl containing 0.02 M NaHCO₃ (giving a pH of 6.5-7.0) was used and determinations were carried out, in duplicate, using the method of Ironside and Love (1958) as modified by Cowie and Little (1967). An MSE homogenizer, fitted with a 25 ml masticator attachment, was used. Values were calculated as soluble protein nitrogen expressed as a percentage of total protein nitrogen (i.e., percentage SPN).

RESULTS AND DISCUSSION

The chub mackerel used in this study weighed about 100 g and were considered relatively small. The proximate composition of the flesh is shown in Table 1; the lipid content was relatively low and the moisture content high. It is now well established that there is an inverse linear relationship between lipid and water content in 'fatty' fish and that the relative proportions of these two components vary depending on season of the year and plane of nutrition (Love, 1970). The following results must, therefore, be considered as an indication of the storage characteristics of lean, chub mackerel.

Table 1
Proximate composition

(% w/w)	Mean	Range	Number of replicates
Crude protein	18.0	16.7- 19.1	8
Total lipid	1.9	0.9- 3.3	22
Moisture	78.2	76.5-81.2	8
Ash	1.2	1.1 1.4	4

Figs. 1 and 2 show the percentage SPN of chub mackerel flesh, at intervals during storage of up to 12 months, at -30 and -10°C respectively. As is common with this determination, the scatter in the values is high (Connell, 1968). There is no detectable difference in the percentage SPN levels in the fast- and slow-frozen samples and, more surprisingly, no large decrease with time in percentage SPN at either temperature. In a study with a different species of chub mackerel (*Rastrelliger neglectus*), Keay *et al.* (1972) measured the changes in percentage SPN in the flesh during 3 months of storage at -14 and -30°C. Although they were in some doubt about the significance of their results in relation to sampling variation, the values appeared to fall to 60 percent of the initial value in samples stored at -14°C and to 80 percent in samples at -30°C. Similarly, in trials with sardines (*Sardinella longiceps*) the values after 6 months of storage were 70 percent of the initial value in samples stored at -12.5°C and 80 percent in samples stored at -23°C. (Bose, 1969). Investigations undertaken with cold-water fish have indicated that the percentage SPN of fish muscle falls only very slowly during storage at low sub-zero temperatures. For example, in cod (*Gadus morhua*), stored at -30°C, it takes nearly 10 years for the

percentage SPN to fall to half its initial value (Love, 1966). On the other hand, at high sub-zero temperatures, the values fall much more rapidly, taking only 2 months at -8°C to fall by 50 percent in herring (*Clupea harengus*), a cold-water pelagic fish (Poulter and Lawrie, 1977). Further work will be required to determine whether in general the deteriorative changes occurring in the proteins of frozen tropical fish occur at a slower rate than those in temperate- or cold-water fish. In this respect, it is now well known that the spoilage of tropical fish in ice occurs at a much slower rate than cold-water fish (Disney *et al.*, 1974).

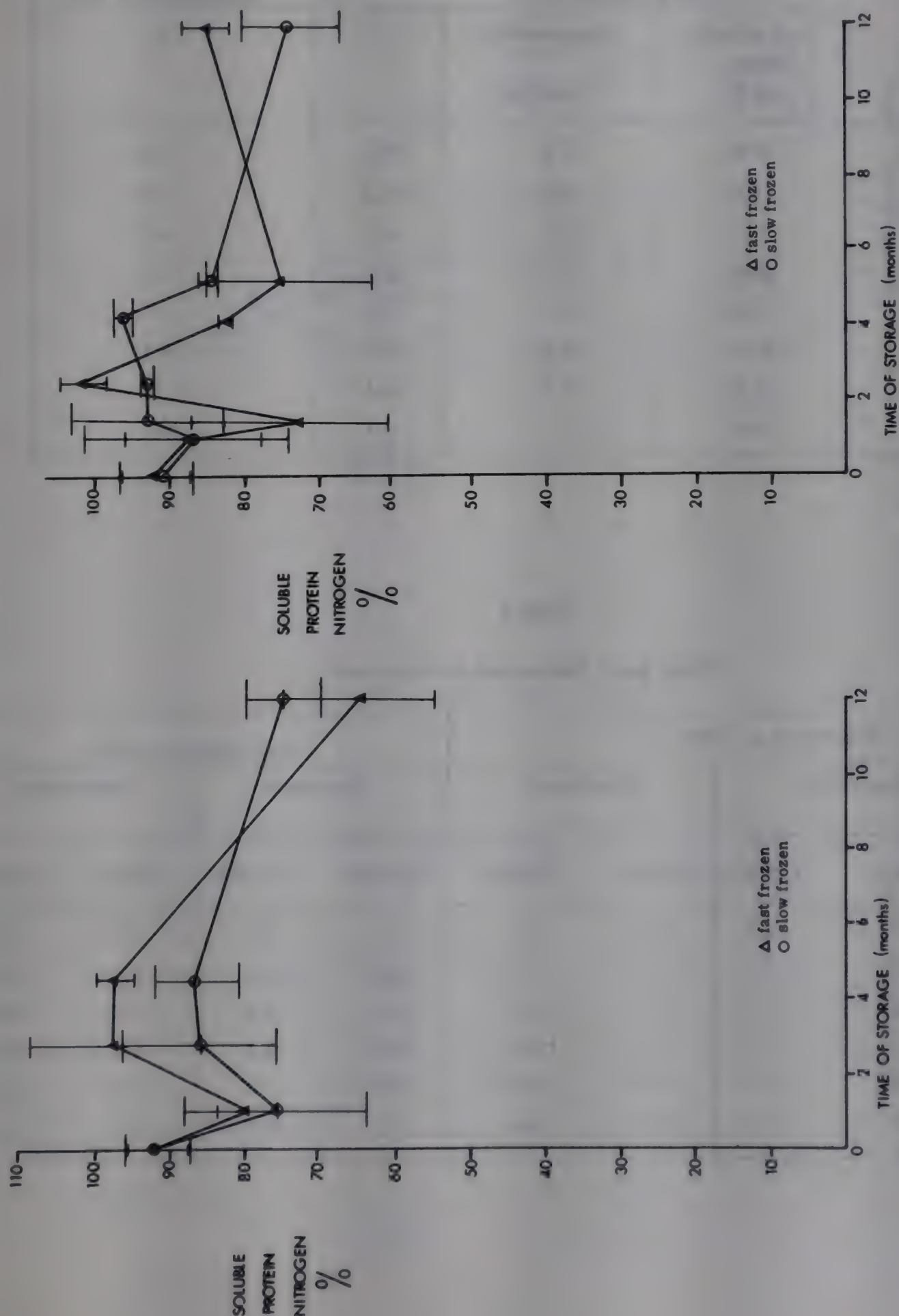


Figure 2 — The effect of storage at -10°C on protein solubility in chub mackerel

Figure 1 — The effect of storage at -30°C on protein solubility in chub mackerel

Table 2

Changes in total volatile bases,
hypoxanthine and pH during frozen storage

Time of Storage (weeks)	Fish stored at -10°C			Fish stored at -30°C
	Total volatile bases (mg %)	Hypoxanthine (μ mole/g)	pH	pH
0	25.9	2.3	6.2	6.2
4	15.9	3.8	6.2	6.2
6	7.9	3.2	6.2	6.2
10	20.9	4.0	6.2	6.2
17	17.0	4.5	6.3	—
21	23.5	2.3	6.2	6.3
32	23.4	4.1	6.3	—
48	20.8	—	6.3	6.1

Table 3

Taste panel, flavour and texture scores

Time of storage (weeks)	Fish stored at -10°C				Fish stored at -30°C			
	Fast-frozen		Slow-frozen		Fast-frozen		Slow-frozen	
	Flavour	Texture	Flavour	Texture	Flavour	Texture	Flavour	Texture
2	7.0	6.6	8.0	7.4	8.4	8.0	8.0	7.0
6	6.4	6.6	7.3	6.7	6.1	4.6	6.4	4.4
10	5.8	5.6	4.8	5.3	6.1	6.6	5.9	6.0
21	4.5	3.8	5.3	5.3	6.2	6.3	6.2	6.0
32	4.5	5.0	3.0	3.0	5.8	7.3	6.3	5.9
48	4.0	4.0	3.4	4.4	4.3	5.6	5.4	5.0

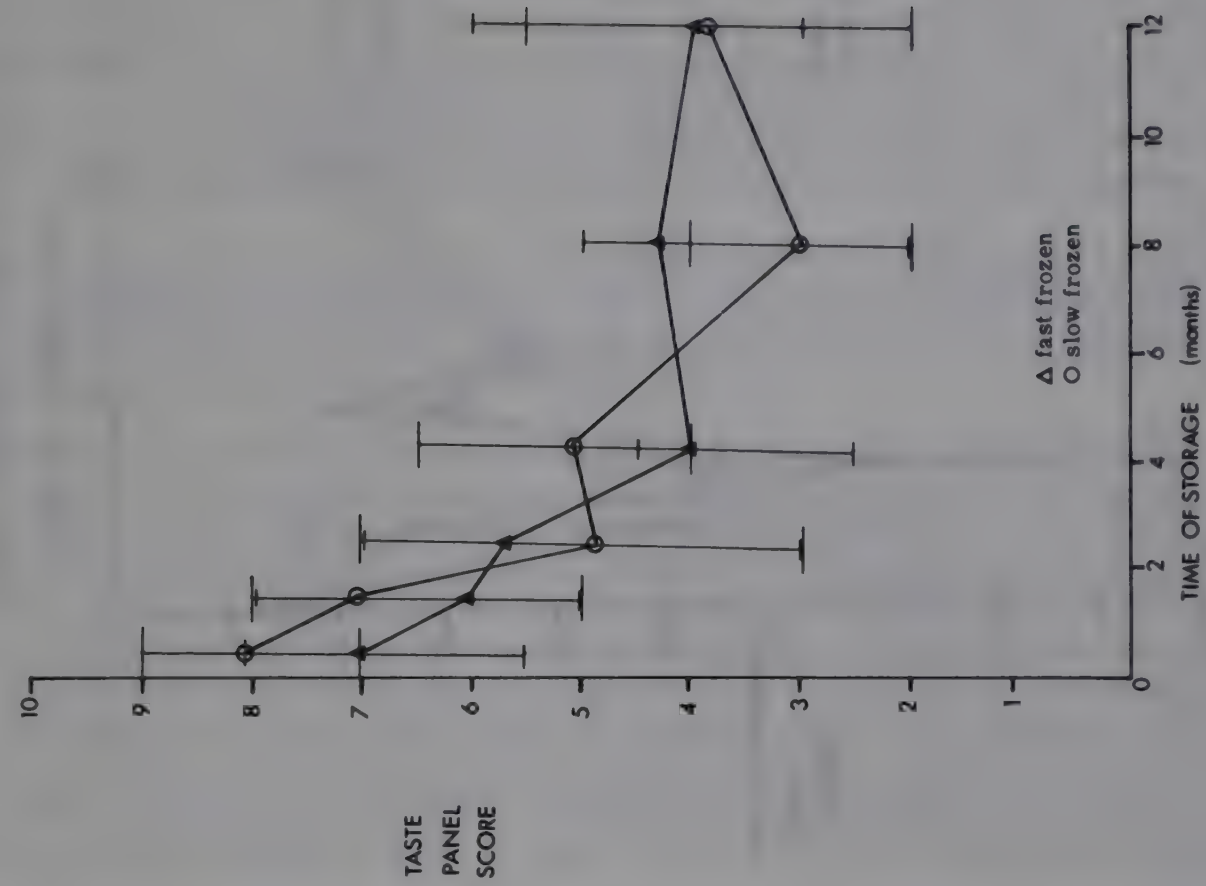


Figure 4 — The effect of storage at -10°C on taste panel scores of chub mackerel

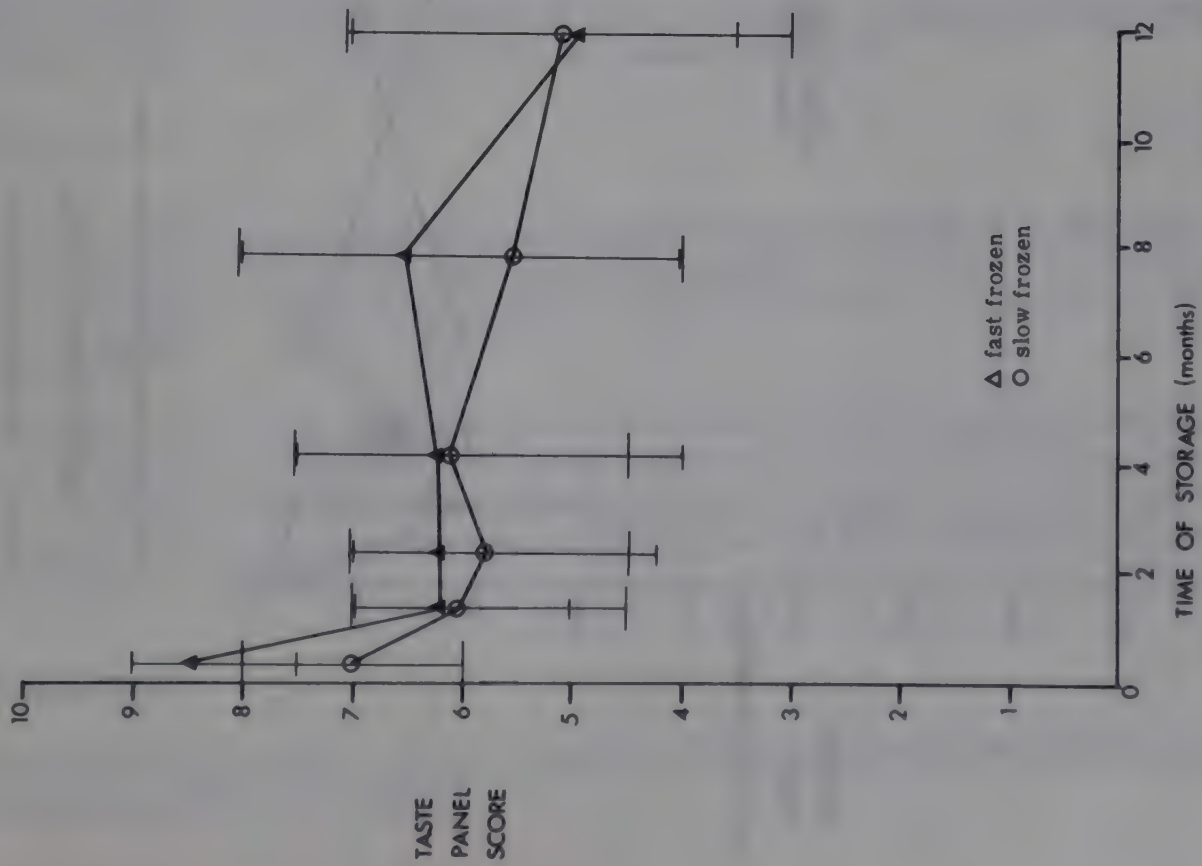


Figure 3 — The effect of storage at -30°C on overall taste panel scores of chub mackerel

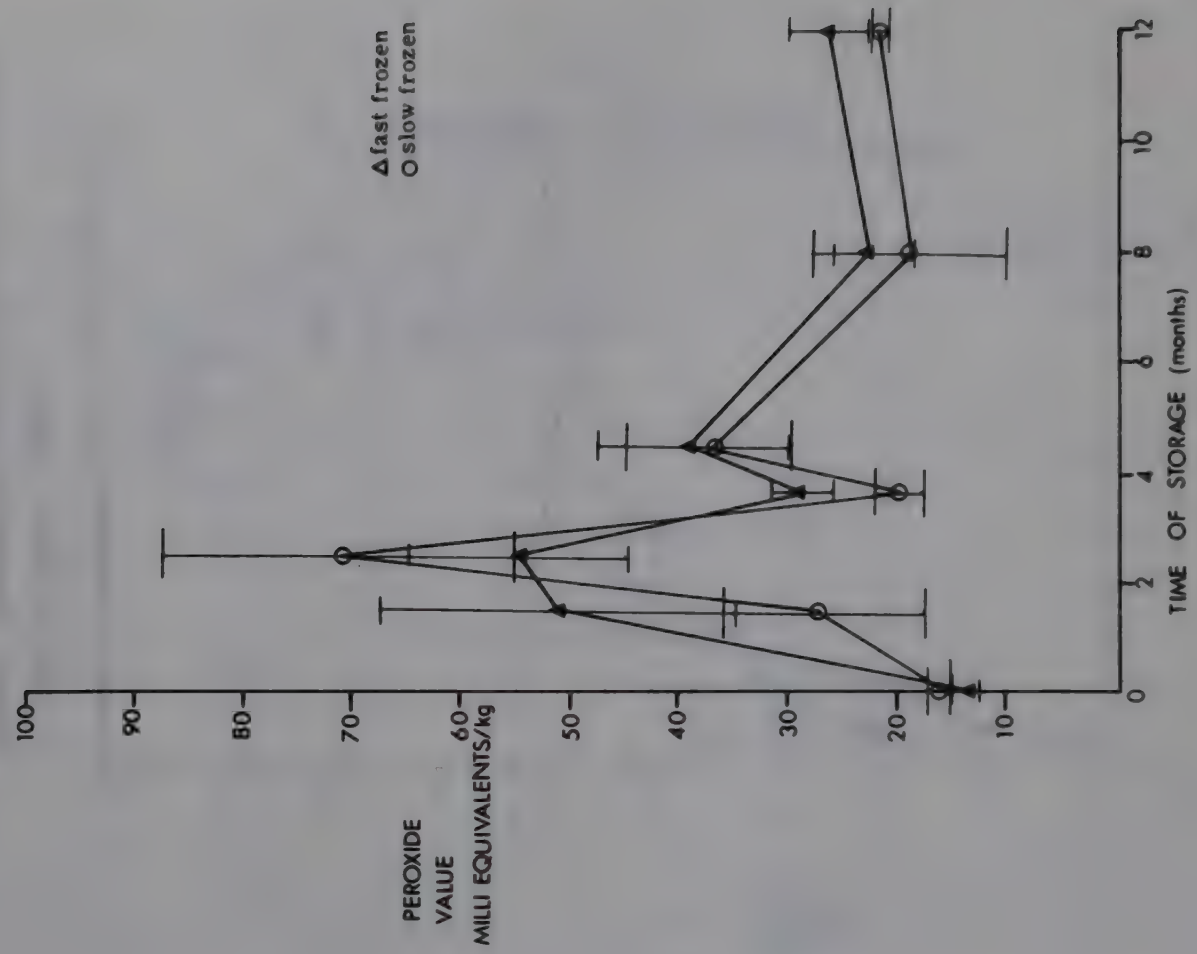


Figure 5 — The effect of storage at -30°C on peroxide value in chub mackerel

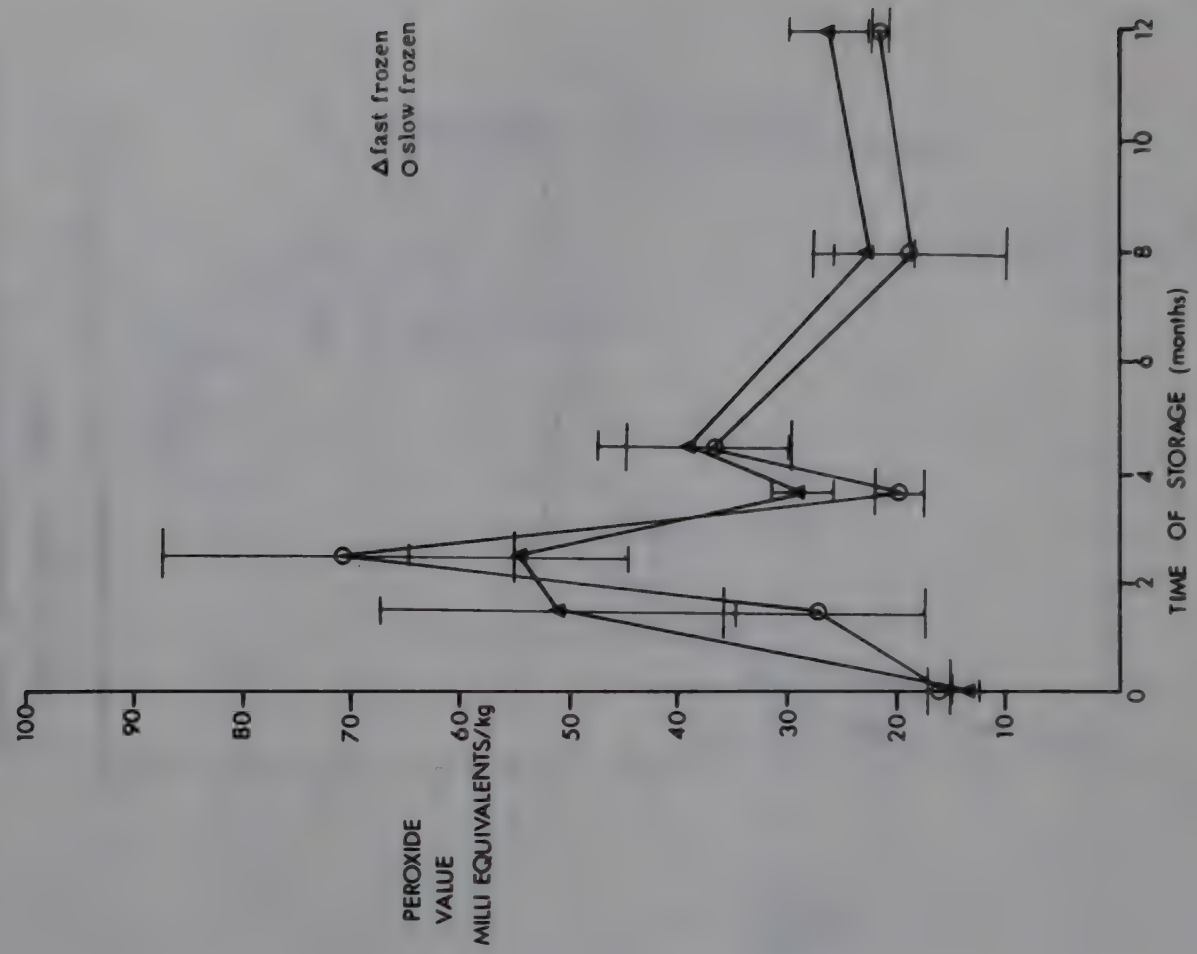


Figure 6 — The effect of storage at -10°C on peroxide value in chub mackerel

In cold-water fish the texture of the muscle has been found to be dependent on the pH and percentage SPN (Cowie and Little, 1966). As indicated in Table 2, the pH of chub mackerel remained almost constant during frozen storage and, as little change in percentage SPN was found, it would be expected that the texture would also have remained fairly constant. The taste panel results (mean flavour and textures scores in Table 3; mean and range in overall scores in Figs. 3 and 4), however, do not support this theory; the texture grades of the samples stored at -10°C decreased markedly with increasing storage whereas the grades for the samples stored at -30°C showed a much smaller decrease. The same pattern was found for flavour and overall scores. There was no significant difference between the scores obtained for the quick- and slow-frozen samples.

The overall taste panel scores indicate that the samples stored at -30°C remained acceptable for at least one year. The acceptability of the samples stored at -10°C , on the other hand, decreased rapidly and approached the limit of acceptability after four months' storage but appeared to stay at or near this level for the remaining period of storage and did not appear to become totally unacceptable.

The deterioration of the flavour of fish muscle during frozen storage involves a complex series of changes and reactions such as the development of rancidity in the fats and degradation of the nucleotides. In fatty fish, rancidity is probably the most important factor as far as flavour acceptability is concerned. Figs. 5 and 6 show the peroxide values of the chub mackerel stored at -30 and -10°C respectively. Although there were no significant differences between the quick- and slow-frozen samples, the peroxide values of the samples stored at -10°C increased rapidly during the first few months of storage and then rapidly decline whereas at -30°C there was only a slight increase over 12 months of storage. Peroxides are intermediate fat breakdown products and hence they accumulate in the early stages of oxidative rancidity and are then broken down. This makes interpretation of a single peroxide value difficult because a very rancid product could have a low peroxide value. However, the pattern of changes in peroxide values obtained in the samples studied here suggests that those stored at -10°C became rancid very rapidly whereas, in those stored at -30°C , the development of rancidity was much slower.

The values for TVB and hypoxanthine in quick-frozen chub mackerel at intervals during 12 months of storage at -10°C are given in Table 2. At this temperature bacterial growth and autolytic enzymic activity may not be completely arrested (Stokes, 1968). This is borne out by the fact that the hypoxanthine content rose during storage. However the TVB results indicate that little, if any, protein degradation occurred in the samples. The characteristic bitter, cold store taste of frozen lean fish may be linked to nucleotide degradation and, in particular, to hypoxanthine production (Jones, 1961). In this study hypoxanthine levels were found to rise during storage at -10°C . Although this may have been a contributory factor to the decrease in their acceptability, it is probable that it was far outweighed by the increase in rancidity.

CONCLUSIONS

For the low-fat specimens of chub mackerel the shelf-life during storage at -30°C was at least one year. In commercial practice, however, cold stores which are nominally set at -30°C often run at much warmer temperatures. The results also indicate that storage of chub mackerel for 2 or 3 months at -10°C will not result in a serious loss of quality.

It is impossible to gain an overall indication of the frozen shelf-life of tropical fish from the results on one species; similar investigations must be carried out on other tropical species and also on chub mackerel caught at other seasons of the year, i.e., of the other available information, suggest that tropical fish have a longer frozen storage life than similar cold or temperate species. Whether or not this is correct will be determined only by further investigations.

ACKNOWLEDGEMENTS

The help and patience of Mr. R. Beales, Director of Fisheries, Brunei and his staff in obtaining the samples of chub mackerel is gratefully acknowledged.

REFERENCES

- AOAC, Peroxide values, Official methods of analysis. Washington D.C., Association of Official Agricultural Chemists, 419 p. 10th ed.
1965
- Beatty, S.A. and N.E. Gibbons, The measurement of spoilage in fish *J.Biol.Board Can.*, 3(1):77-91
1937
- Bligh, E.G. and W.J. Dyer, A rapid method of total lipid extraction and purification, *Can.J.Biochem. Physiol.*, 1959 37:911-7
- Bose, A.N., Freezing of tropical fish. In Freezing and irradiation of fish, edited by R. Kreuzer, London, Fishing News (Books) Ltd., pp. 179-88
1969
- Bradstreet, R.B., The Kjeldahl method for organic nitrogen. London, Academic Press.
1965
- Connell, J J., The effect of freezing and frozen storage on the proteins of fish muscle. In Low temperature biology of foodstuffs, edited by J. Hawthorn and E.J Rolfe. London, Pergamon Press
1968
- Cowie, W.P. and W.T. Little, The relationship between toughness of cod stored at -29°C and its muscle protein solubility and pH. *J.Food Technol.*, 1:335
1966
- _____, The relation between toughness of cod stored at -7°C and -14°C , its muscle protein solubility and pH. *J.Food Technol.*, 2:217
1967
- Disney, J.G., R.C. Cole and N.R. Jones, Considerations in the use of tropical fish species. In Fishery products, edited by R. Kreuzer. West Byfleet, Surrey, Fishing News (Books) Ltd., pp. 329-37
1974
- Ironside, J.I.M. and R.M. Love, Studies on protein denaturation in frozen fish. 1. Biological factors influencing the amounts of soluble and insoluble protein present in the muscle of North Sea cod. *J.Sci.Food Agric.*, 9:597-617
1958
- Jones, N.R., *Proc.Flavour Chem.Symp.*, Campbell Soup Co., Camden, N.J., p. 61
1961
- Jones, N.R., J. Murray and J.R. Burt, Automated analysis of hypoxanthine. *J.Food Sci.*, 30:791-4
1965
- Ke, P.J., D.M. Nash and R.C. Ackman, Quality preservation in frozen mackerel. *J.Inst.Can.Sci.Technol. Aliment.*, 1976 9(3):135-8
- Keay, J.N., P. Rattagool and R. Hardy, Chub mackerel of Thailand (*Rastrelliger neglectus*, Van Kampen): A short study of its chemical composition, cold storage and canning properties. *J.Sci.Food Agric.*, 23: 1359-68
1972
- Krone, W., Frozen fish marketing in developing countries. In Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 189-94
1976
- Love, R.M., The freezing of animal tissue. In Cryobiology, edited by K.T. Meryman, London, Academic Press, pp. 317-405
1966
- _____, The chemical biology of fishes. London, Academic Press, 262 p.
1970

- Nair, P.G.V., K. Gopakumar and M.R. Nair, Lipid hydrolysis in mackerel (*Rastrelliger kanagurta*) during frozen storage. *Fish. Technol. Soc. Fish. Technol., Ernakulam*, 13:111-4
1976
- Norman, G.A., M.J. Follett and D.A. Hector, Quantitative thin-layer chromatography of ATP and the products of its degradation in meat tissue. *J. Chromatogr.*, 90:105-11
1974
- Pearson, D., The chemical analysis of food. London, Churchill, 6th ed. p. 9
1970
- Poulter, R.G. and R.A. Lawrie, Studies on fish muscle protein. Nutritional consequences of the changes occurring during frozen storage. *J. Sci. Food Agric.*, 28:701-9
1977
- Radhakrishnam, A.G., K.K. Solanki and R. Ventakataraman, Preliminary studies on freezing characteristics of Bombay duck (*Harpodon nehereus*). *Fish. Technol. Soc. Fish. Technol., Ernakulam*, 10:124-31
1973
- Rattagool, A., B. Rattagool and K. Tipkong, A study of the quality changes of frozen stored chub mackerel. Experimental report. Bangkok, Ministry of Agriculture, Food Technology Section, Marine Research and Investigation Division, Department of Fisheries
1972
- Shenoy, A.V., Freezing characteristics of tropical fishes. 3. Spotted seer (*Scomberomorus guttatus*). *Fish. Technol. Soc. Fish. Technol., Ernakulam*, 13:105-10
1976
- Shenoy, A.V., V.K. Pillai, Freezing characteristics of tropical fishes. 1. Indian oil sardine. *Fish. Technol. Soc. Fish Technol. Ernakulam*, 13:105-106
1971
- Stokes, J.L., Nature of psychrophilic microorganisms. In Low temperature biology of foodstuffs, edited by J. Hawthorn and E.J. Rolfe. London, Pergamon Press, p. 221
1968
- Trofimchuk, G.D. and T.A. Pervuninskaya, Changes in lipids of fish muscles during storage. *Ryb. Khoz. Mosk.*, 9:50-1
1974
- Wu, C.G. and M. Toyomizu, Changes in lipids of jack mackerel muscle during low temperature storage. *Sci. Bull. Fac. Agric. Kyushu Univ.*, (27): 165 p
1973

RADIATION PRESERVATION OF SEAFOODS: DEVELOPMENT OF DEHYDRO-IRRADIATION PROCESSES FOR SHRIMP (*PENAEUS INDICUS*) AND BOMBAY DUCK (*HARPODON NEHEREUS*)

by

Norman F. Lewis
Biochemistry and Food Technology Division
Bhabha Atomic Research Center
Bombay, India

Abstract

Dehydro-irradiation processes developed for Bombay duck laminates and shrimp offer good scope for stabilizing these seafoods at ambient temperature. The products obtained are far superior in organoleptic attributes than those prepared by the conventional sun-drying method.

INTRODUCTION

With an annual landing of over 2 million tonnes of fish, India ranks among the major seafood producers in the world. Nevertheless, the population suffers from an inadequate supply of protein, particularly animal protein, in the diet. It has been estimated that meat, poultry and dairy products account for 10 percent of the requirements, necessitating supplementation of animal protein from seafoods. The importance of increasing the production of seafoods needs to be emphasized from the point of view of improving the nutrition of the population.

Fish is a highly perishable commodity but, since it is available in large quantities only during the peak season (which may extend from 1 to 3 months), it has to be processed rapidly. The preference in India is for fish in a fresh condition; however, inadequate supplies of ice and poor transportation and distribution facilities have resulted in fresh fish being restricted to the coastal areas. Frozen fish is available only in negligible quantities and the freezing industry caters essentially for the export market. Drying is probably the most practical method of preserving seafoods; the major advantage is that refrigerated conditions, during transportation and storage, are not required. Moreover, because of the substantial reduction in weight, after drying, transportation and storage costs are considerably reduced.

In India, sun-drying is the most prominent method for the dehydration of seafoods, particularly Bombay duck (*Harpodon nehereus*), mackerel (*Rastrelliger kanagurta*) and tiny shrimp (*Parapenaeopsis stylifera*). However, owing to the unhygienic practices prevailing during sun-drying, the final product is of very poor quality. In many cases the dehydration is inadequate since the peak season of availability coincides with the monsoon months, resulting in the indiscriminate use of toxic chemicals for controlling putrefaction.

In our laboratory processes have been developed using combination of heat and gamma radiation to stabilize seafoods for preservation at ambient temperature. The seafoods selected for this study were Bombay duck and shrimp (*Penaeus indicus*).

Bombay duck, which comprises more than 10 percent of the annual catch, is not suitable for freezing and canning, mainly due to the high content of free water and the extreme lability of its proteins. Most Bombay duck is preserved using the traditional sun-drying method; however, commercial products are susceptible to rapid spoilage by moulds. This leads to impairment of quality attributes such as colour, flavour and texture. The dehydro-irradiation process developed in our laboratory is capable of preserving Bombay duck for a period of four months at ambient temperature.

PROCESSING TREATMENT FOR BOMBAY DUCK

Fresh Bombay duck (*Harpodon nehereus*) were purchased in a local market and brought to the laboratory in ice. The fish were washed, eviscerated and filleted. The fillets were slit open and pressed between two metal

plates for 5 min. The pressure caused the release of tissue fluid which amounted to about 20 percent. The laminates were kept in trays and steam blanched for 15 sec in a steam retort. Dehydration of blanched and unblanched laminates was carried out in an air drier at 55-60°C until the moisture content was reduced to 35-40 percent. The semi-dried laminates were packed in polycell pouches and irradiated at 0.25 and 0.5 Mrad in a Co⁶⁰ Package Irradiator (IR-11), at a dose rate of 0.24 Mrad/h (for flow diagram see Fig. 1). After irradiation, blanched and unblanched laminates were stored at room temperature (28-30°C). Table 1 indicates the shelf-life of Bombay duck laminates (35-40 percent moisture) subjected to various treatments. Unirradiated samples spoil within 4 to 8 days with heavy mould growth (10^7 - 10^8 moulds/g) and intense ammoniacal odours while irradiated samples were stable for 90 to 120 days. The blanching treatment, which was found to enhance the storage life of 0.25 Mrad samples, had the added advantage of significantly retarding brown discoloration and totally inhibiting the formation of ammoniacal odours. Thus, blanched irradiated (0.25 Mrad) samples were stable at room temperature for 120 days and showed less discoloration than unblanched laminates which had a shelf-life of 90 days.

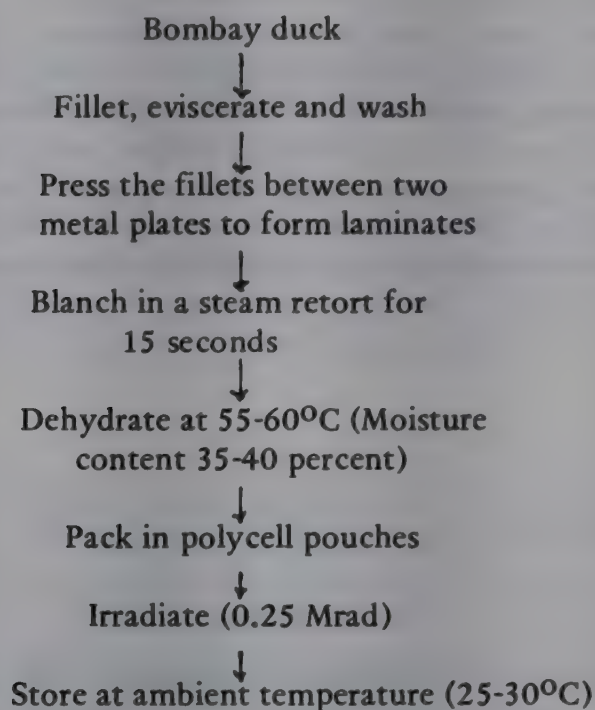
Table 1

Extension in the shelf-life of semi-dried (35-40 percent moisture)
Bombay duck laminates with different treatments

Processing treatment	Shelf life at ambient temperature (days)	Spoilage characteristics
Unblanched control	4 - 5	Heavy mould growth, ammoniacal odours
Unblanched 0.25 Mrad	90 - 100	Intense browning, strong ammoniacal odours
Unblanched 0.5 Mrad	120 - 150	Intense browning, strong ammoniacal odours
Blanched control	7 - 8	Heavy mould growth, strong ammoniacal odours
Blanched 0.25 Mrad	120 - 150	No discoloration, no ammoniacal odours. Acceptable
Blanched 0.5 Mrad	120 - 150	Slight discoloration, no ammoniacal odours

Figure 1

Flow diagram of the dehydro-irradiation process for Bombay duck laminates



QUALITY OF SEMI-DRIED BOMBAY DUCK LAMINATES

Fig. 2 depicts the status of freshness indices, i.e., organoleptic score (OS), total volatile basic nitrogen (TVBN), trimethylamine (TMA) and total bacterial count (TBC) in blanched and unblanched dehydro-irradiated samples. The unirradiated samples, both unblanched and blanched, spoiled rapidly (4-8 days) primarily due to heavy mould growth; hence, no assessment of chemical indices was made in the controls. As can be seen in Fig. 2, the blanching treatment resulted in considerable reduction of TMA and TVBN values compared with the unblanched samples. However, although TMA and TVBN are useful quality parameters for fresh sea foods, it was observed that both unblanched and blanched dehydro-irradiated laminates had low levels of TMA and TVBN

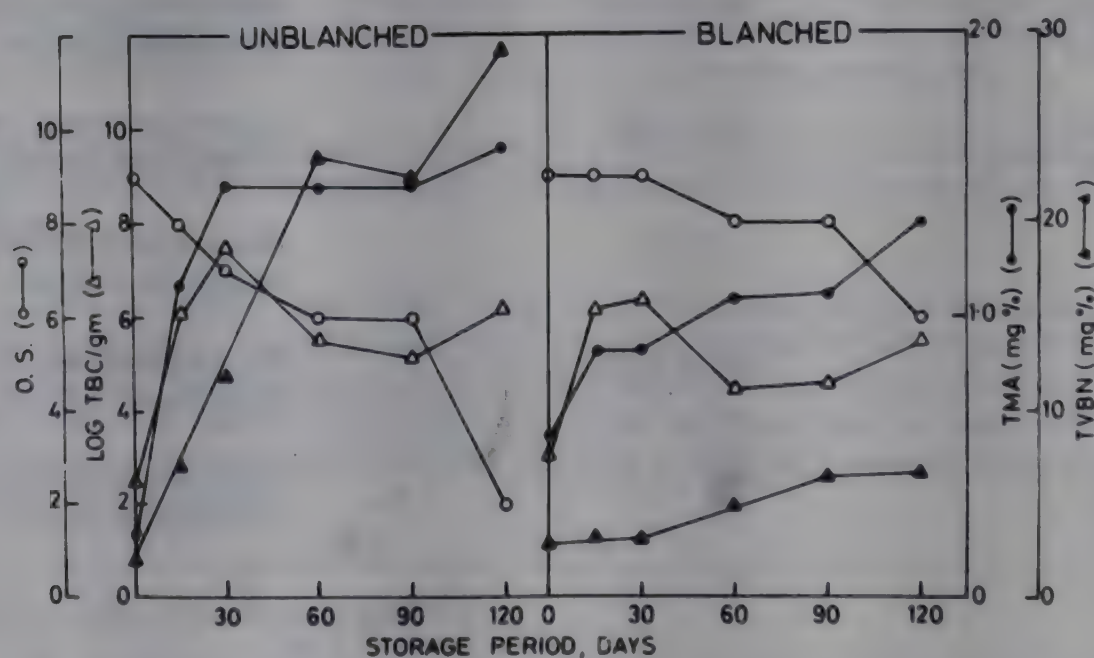


Fig. 2 — Effect of blanching on freshness parameters of radurized semi-dried Bombay duck laminates

even when the samples had poor OS ratings. These findings indicate that TMA and TVBN are poor indices of freshness of dehydro-irradiated seafoods which is in agreement with earlier findings from this laboratory (Kumta *et al.*, 1972; Alur *et al.*, 1975). The absence of ammoniacal odours in the blanched irradiated samples could be attributed to the inactivation of enzyme systems which are responsible for de-amination of amino acids, leading to the formation of amines and ammonia.

EXTENT OF BROWNING IN BLANCHED AND UNBLANCHED LAMINATES

The method for the extraction of brown pigment from Bombay duck laminates was standardized. Fish suspensions containing different concentrations of trypsin were incubated at 45°C for 0.5, 1 and 2 h. From Table 2 it is evident that, by using 60 mg trypsin in this suspension and incubating at 45°C for 1 h, the maximum amount of pigment was extracted; these conditions were therefore used for the extraction of the brown pigment. Fig. 3 shows the extent of browning in unblanched and blanched laminates exposed to 0.25 and 0.50 Mrad. The browning was more intense in unblanched laminates than in blanched ones; this suggests that certain constituents such as sugars and amino acids which are responsible for browning were leached out during the blanching process. Yu *et al.*, (1969) observed that the leaching process alone was capable of retarding browning in radiation sterilized cod patties stored at ambient temperatures.

REHYDRATION RATIO

Table 3 indicates that blanched laminates have better rehydration properties than unblanched ones. However the rehydration ratios in both unblanched and blanched laminates decreased during storage at room temperature.

When semi-dried laminates are further dried to a moisture content of 5-10 percent, insect infestation which normally occurs during storage can be controlled effectively by a low dose of 15 krad.

Table 2

Influence of time and trypsin concentration on the extraction of brown pigment from dehydro-irradiated Bombay duck laminates (OS at 400 m u)

Concentration of trypsin (mg)	Incubation time (h)		
	0.5	1	2
20	0.13	0.17	0.17
40	0.17	0.21	0.24
60	0.20	0.25	0.25
80	0.22	0.25	0.25

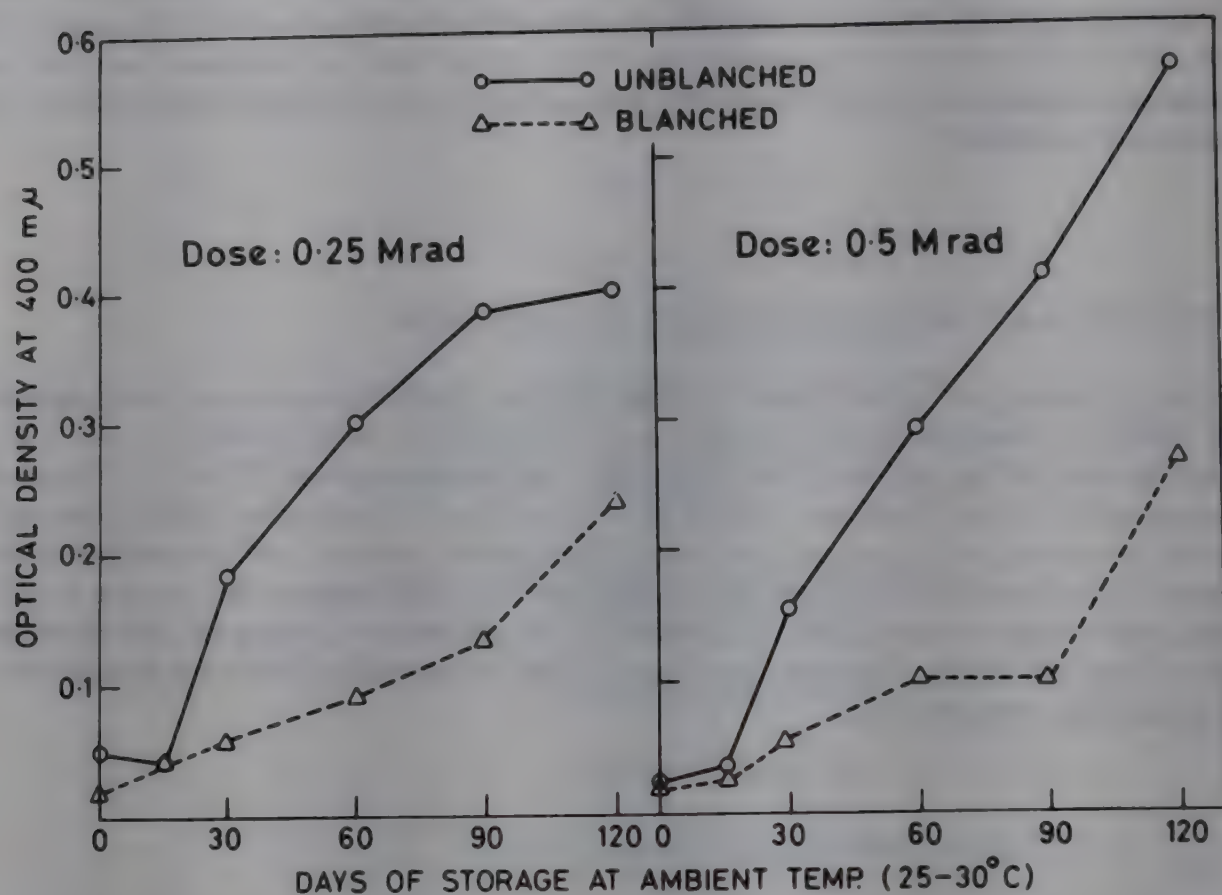


Fig. 3 — Effect of blanching on browning in radurized semi-dried Bombay duck laminates during storage at ambient temperature.

Table 3

Rehydration properties of unblanched and blanched dehydro-irradiated Bombay duck laminates

Days of storage	Rehydration ratio	
	Unblanched	Blanched
0	1.90	2.4
30	1.75	2.2
60	1.70	2.1
90	1.55	2.1
120	1.55	2.0

Rehydration ratio = $\frac{\text{Wt. of sample before rehydration}}{\text{Wt. of sample after rehydration}}$

RADIATION DISINFESTATION OF SUN-DRIED BOMBAY DUCK

Commercially sun-dried products have a good market both for inland distribution and export. However, as mentioned earlier, owing to the high humidity and temperature and the poor storage conditions, the product is often infested with insects. Fumigation processes are not effective in eliminating the eggs which lead to subsequent deterioration and large quantities of this low-quality material are wasted and used as manure. It was found that dried laminates packed in polycell pouches and subjected to a low dose of 20 krad were free from insect damage for over one year. Fig. 4 depicts the radiation disinfection of dried Bombay duck laminates.

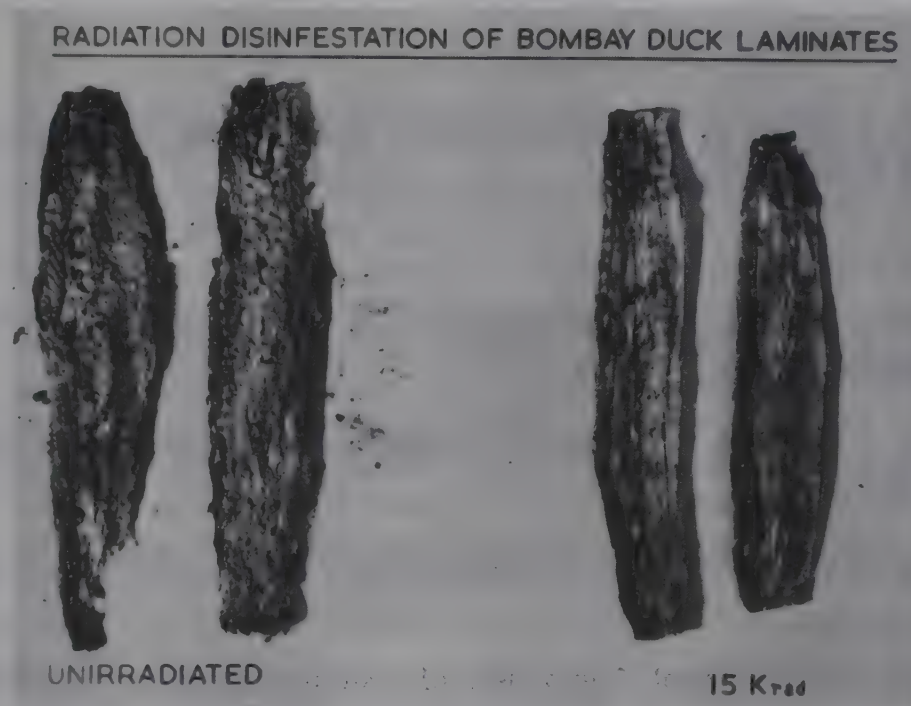


Fig. 4 — Radiation disinfection of Bombay duck laminates: commercially available sun-dried Bombay duck laminates were packed in polythene bags (700 gauge) and irradiated (15 krad); unirradiated laminates served as controls. Samples were examined for infestation during storage at ambient temperature.

DEHYDRO-IRRADIATION OF SHRIMP

The process described below was developed for stabilizing the storage of shrimp at ambient temperature and to obtain a product which is superior in quality to the commercially available sun-dried products (Gore *et al.*, 1970). The process includes: (1) blanching in a 10 percent solution of NaCl at 80°C for 5 min to inactivate the autolytic enzymes that are responsible for blackspot development; (2) dip treatment in 0.5 percent sorbic acid for 1 h to control mould growth; (3) drying to 40 percent moisture level for better retention of rehydration properties; (4) sealing in polyethylene pouches to prevent contamination and (5) irradiation at 100 krad. The reduced water activity in dehydro-irradiated shrimp retards the rapid growth of bacteria during storage and maintains the total count at about 10^4 /g. The combined treatments produce a synergistic effect which results in a 4-6 month storage life of the product at ambient temperature. Control shrimp were found to spoil within 4 weeks.

MICROBIOLOGICAL SAFETY

When food products are stored at room temperature their freedom from any microbiological hazard must be ensured. *Clostridium botulinum* Type E has been found to be etiological agent involved in several food poisoning outbreaks in Germany, Japan, U.S.A. and other countries. Since this organism produces an extremely potent toxin it must be eliminated from the finished product.

Representative samples of both unirradiated and irradiated semi-dried Bombay duck laminates, as well as unirradiated and irradiated semi-dried shrimp, were not found to contain *G. botulinum* toxin during their entire storage period as assessed by the method of Duff *et al.*, (1956). This may be due to the low water activity of the Bombay duck laminates and the high salt concentration (3-4 percent) of the semi-dried shrimp. Nevertheless, to ensure the safety of these products prior to marketing, inoculated pack studies should be made (Hussain *et al.*, 1977) to examine whether *C. botulinum* Type E spores are capable of surviving the above processing treatments and producing toxin during storage of the products. In any case, since semi-dried products are rehydrated and then cooked, there is no botulism hazard in these products. It has been reported that the most heat-resistant spores of *C. botulinum* Type E are inactivated by a factor of 10^{10} with only 20 sec boiling at 100°C and the toxins are even more heat-sensitive being destroyed after heating for a min at 65°C (Rhodes *et al.*, 1966).

ACKNOWLEDGEMENT

The author's thanks are due to Dr. M.S. Gore, Mr. S.N. Doke and Mr. S.V. Ghadi of this Division whose contributions were essential to the work reported.

REFERENCES

- Alur, M.D. *et al.*, Suppression of spoilage rates of Bombay duck (*Harpodon nehereus*) homogenates by gamma radiation. *Agric.Biol.Chem.*, 39:1201
1975
- Duff, J.T., G.G. Wright and A. Yarinski, Activation of *Clostridium botulinum* Type E toxin by trypsin. *J. Bacteriol.*, 1956:455
1956
- Gore, M.S., Dehydro-irradiation process for tropical shrimps. *Food Technol.*, Champaign, 24:10
1970
- Hussain, A.M., D. Ehlermann and J.F. Diehl, Comparison of toxin production by *Clostridium botulinum* Type E in irradiated vacuum-packed trout (*Salmo gairdneri*). *Arch.Lebensmittelhyg.*, 28:23
1977
- Kumta, U.S. *et al.*, Radiation preservation of seafoods: review of research in India. In Radiation preservation of food. *Proc.Ser.IAEA*, (STI/PUB/317):403-25
1973
- Rhodes, D.N., T.A. Roberts and G. Hobbs, A discussion of radiation preservation of fish in developing countries. In Application of food irradiation in developing countries. *Tech.Rep.Ser.IAEA*, (54):39-63
1966
- Yu, T.C., M.K. Landers and R.O. Sinnhuber, Browning reaction in radiation sterilized seafood products. *Food Technol.*, Champaign, 23:90
1969

REDUCING BLOWFLY SPOILAGE DURING SUN-DRYING OF FISH IN MALAWI USING PYRETHRUM

by

P.J. Meynell
Namiasi Fish Processing Laboratory
Fisheries Department
P.O. Box 53, Mangochi, Malawi

Abstract

During the rainy season up to 30 percent by weight of fish wastage is caused by blowfly maggots (*Chrysomya* spp.) during the sun-drying of small (10-15 cm) freshwater fish (*Haplochromis* and *Lethrinops* spp.) from Lake Malawi. Previous work with insecticides, has been on large dried fish to minimize spoilage due to *Dermestes* spp. during storage, but this problem is minimal in Malawi where the dried fish is eaten within 2-3 weeks of processing. Pyrethrum is a suitable insecticide; it is highly repellent and photolabile and leaves little residue, which is of low mammalian toxicity. Preliminary work showed that a system of recycling a solution of pyrethrum, synergised by piperonyl butoxide, over boxes of wet fish was superior to spraying, fogging and dipping since these are either ineffective or leave high residues within such small fish. A simple bioassay technique showed that the minimum effective concentration is about 0.02 percent pyrethrum and 0.04 percent piperonyl butoxide. The highest concentration which gives acceptable residues below the WHO tolerance levels lies between 0.05 and 0.1 percent pyrethrum. Semi-commercial runs showed that 30 l of recycled mix (0.033 percent initial concentration) would treat 60 boxes of 60 lb (27.3 kg) of wet fish adequately at a cost of about 6.4 tambalas per box. This treatment decreased the wastage by 7.9 percent (or an increase in dried weight yield of 2.3 percent) saving up to 20 tambalas per 60 lb (27.3 kg) of wet fish.

INTRODUCTION

Sun-drying of unsalted fish is one of the most important methods of processing fish in Malawi and is likely to remain for so many years. The fish which are most commonly sun-dried are the *Lethrinops* and *Haplochromis* species. These are small cichlids up to 15 cm in length known locally as chisawasawa and utaka. The chisawasawa are caught mainly by commercial trawlers while the utaka are caught mainly by traditional fishermen. About 5 000-6 000 tonnes of each type are caught each year; about 16 percent of the chisawasawa and 33 percent of the utaka are caught in the rainy season, December to March. Probably about 75 percent of these fish will be sun-dried and the rest sold fresh.

Sun-drying is usually carried out on racks made of bamboo or chicken wire, about 1-1.5 m above the ground. The dry season, April to November, is problem-free and the fish dry to a moisture content of less than 20 percent within 3-5 days. In the wet season it is still possible to dry the fish, since the rain comes mostly at night (when the fish can be covered with polythene sheeting) and a succession of fine days is not uncommon but conditions of high temperatures and high relative humidities are optimum for the maturation of blowflies, *Chrysomya albiceps*, *Chrysomya chloropyga putoria* and *Chrysomya regalis*.

The flies lay their eggs in the mouth of gills of the fish on the first or second day of drying and, after 24 hours incubation, they hatch into maggots. The maggots grow rapidly to the pupation stage in a further 3-4 days and feed on the fish. Within that time they can destroy the fish completely leaving nothing but skin and bone. Over the past two years estimates of the wastage of chisawasawa at one particular landing on Lake Malawi have been 26.6 percent in 1975-76 and 10.3 percent in 1976-77; this variation is in direct proportion to the amount of rain which fell, 35 and 20 inches respectively. Fig. 1 shows the weekly variation in wastage depending upon rainfall and average daily hours of sunshine in the rainy season.

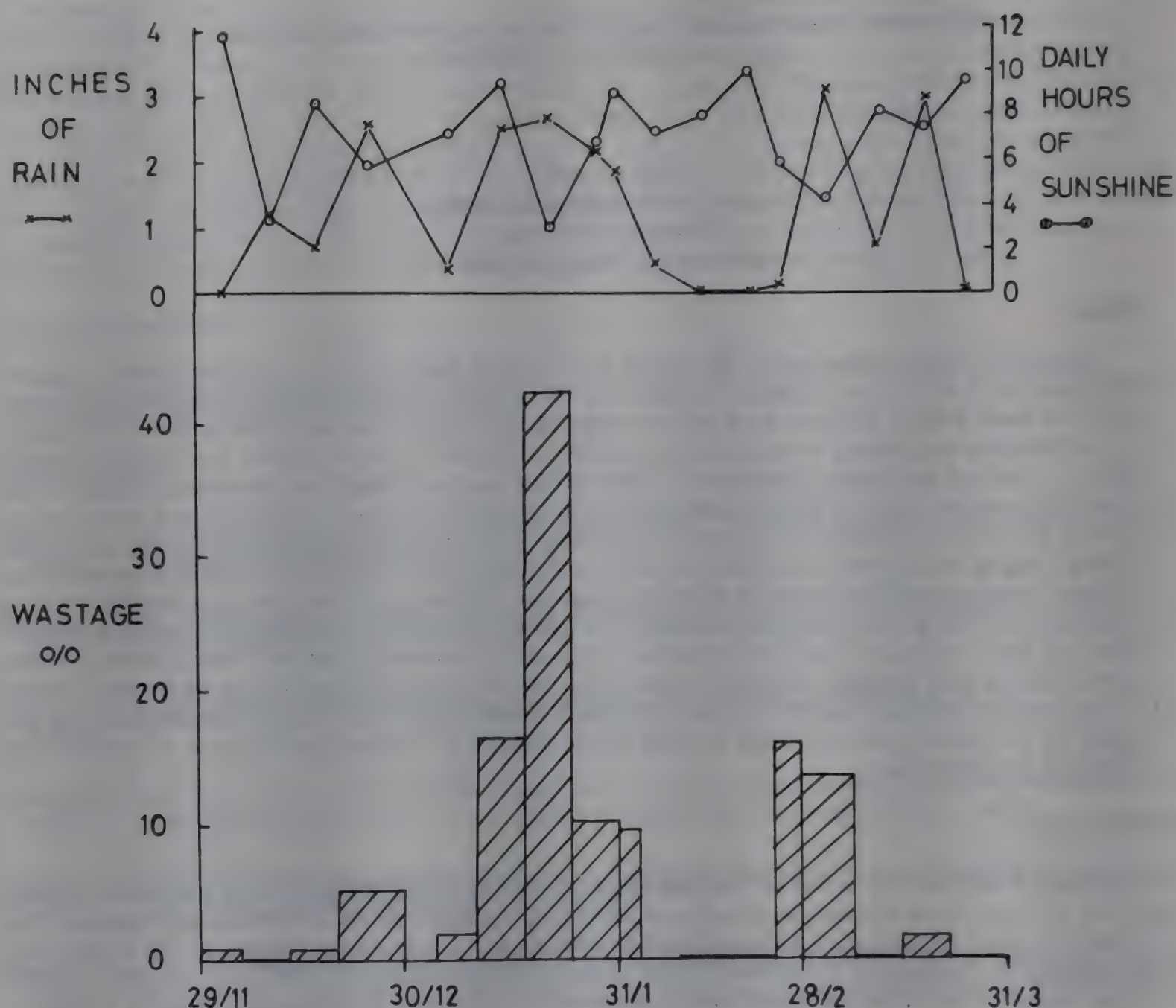


Fig. 1 — Percentage wastage of drying fish due to blowfly attack, Dec. 1976-March 1977. At one site on Lake Malawi correlated with weather conditions.

The other major pest of sun-dried fish is the beetle *Dermestes maculatus*. This is common in Malawi, especially where dried fish are stored. They attack only the fish which have a low moisture content and they mature much more slowly than blowflies (about 40-50 days). They do most of their damage toward the end of the larval stage, so that it becomes serious only after about a month of storage. In Malawi most of the dried fish is eaten within 2-3 weeks of processing and *Dermestes* are, therefore, not much of a problem. When large quantities of dried fish have to be stored for several months, phosphine gas has been used as a fumigant with complete success.

The main insect pest of the dried fish trade in Malawi is thus the blowfly. Previous work with pyrethrum in Africa (McLellan, 1964; Green, 1967; Proctor, 1972) has been aimed at control of *Dermestes* beetles during storage. This trial aims to control blowflies with pyrethrum. The other difference between the earlier work and this trial concerns the size of the fish used; much of the previous work has been done on larger fish. e.g., *Tilapia* spp. and *Lates* sp. in which the residues are likely to be lower (McLellan, 1963).

Pyrethrum synergised by piperonyl butoxide has several advantages over other insecticides. It has a repellent as well as an insecticidal action, i.e., the flies are not attracted to lay their eggs inside the fish, so the infestation is minimal from the beginning, it degrades in sunlight and, on cooking, has a low mammalian toxicity. The maximum WHO/FAO recommended levels of pyrethrum and piperonyl butoxide in foodstuffs are 3 ppm and 20 ppm respectively.

EVALUATION METHODS

The objective of the work being carried out in Malawi is to devise a method of application of pyrethrum to the wet fish before drying. Initially it is aimed at the protection of the commercial catches of chisawasawa, but it is hoped that a method for the traditional utaka fishery will be developed later. In order to evaluate the effectiveness and safety of the different methods, the use of pyrethrum on the drying fish is tested by means of bioassay, residue analysis and estimates of wastage reduction.

It was found during the course of the experiments that the best bioassay method consisted of daily counts (about 15 percent of the fish being dried) of fish which were infested either with egg batches or maggots. A comparison of the counts of these two categories in treated and untreated fish showed the repellency action and combined repellency and toxicity of the pyrethrum.

The residue analysis is being undertaken by the Tropical Products Institute (TPI) in London. Cleaning up the extracts is particularly difficult on dried fish, and TPI are currently working on an improved method of analysis for this work. Although preliminary results are available to give some indication of residue levels, they have not yet been correlated with the bioassay results.

Estimates of wastage reduction are the most important test of the method; Table 1 shows how some of the losses occur and how the calculations have been made.

Table 1

Losses experienced during sun-drying chisawasawa

State of fish	Weight (lb) 1/	Weight loss (lb)	Dried weight (%)	Wastage (%)	Wastage reduction (%)
1 box wet fish before drying	60.0	—	—	—	—
Theoretical max. after drying	19.8	40.2	33.0	—	—
Practical max. after drying + losses due to cats, birds, etc.	17.1	42.9	28.5	13.6	—
Untreated control + blowfly damage	15.0	45.0	25.0	25.9	—
Pyrethrum treated + some fly damage	16.5	43.5	27.5	17.1	8.8

1/ 1 lb = 453 g

The Dried Weight Yield Percent (DWY%) is the weight of the dried fish produced from a given wet weight; wastage percent is the loss in weight of dried fish compared to the theoretical maximum dried weight. The wastages quoted for the past two rainy seasons are calculated on the practical maximum dried weight, and the losses due to outside predations etc., have to be added if the true wastage is to be found.

METHODS OF INSECTICIDE APPLICATION

Various methods of application of pyrethrum have been tested. These have included spraying and mist-blowing the mixture on to the fish which are laid out on the racks, and dipping and 'soaking' the fish before they are put out to dry. Spraying and mist-blowing proved cumbersome and ineffective since the insecticide covered only the surface of the fish and was soon degraded by the sun. Dipping involved double handling of the fish and tended to give rise to excessively high residues in the dried product. The 'soaking' method, which has been used for most of the tests to date, consists of pouring the insecticide solution over a washed 60 lb (27.3 kg) box of fish; the mixture percolates down over the fish and flows out of the bottom of the box. In commercial practice the mixture is collected and recirculated over many boxes using either a pump or a series of watering cans (Fig. 2). In both the dipping and soaking methods, the insecticide penetrates into the body cavities of the fish, and is thus protected from the sun's rays, so that it is effective throughout the drying period.

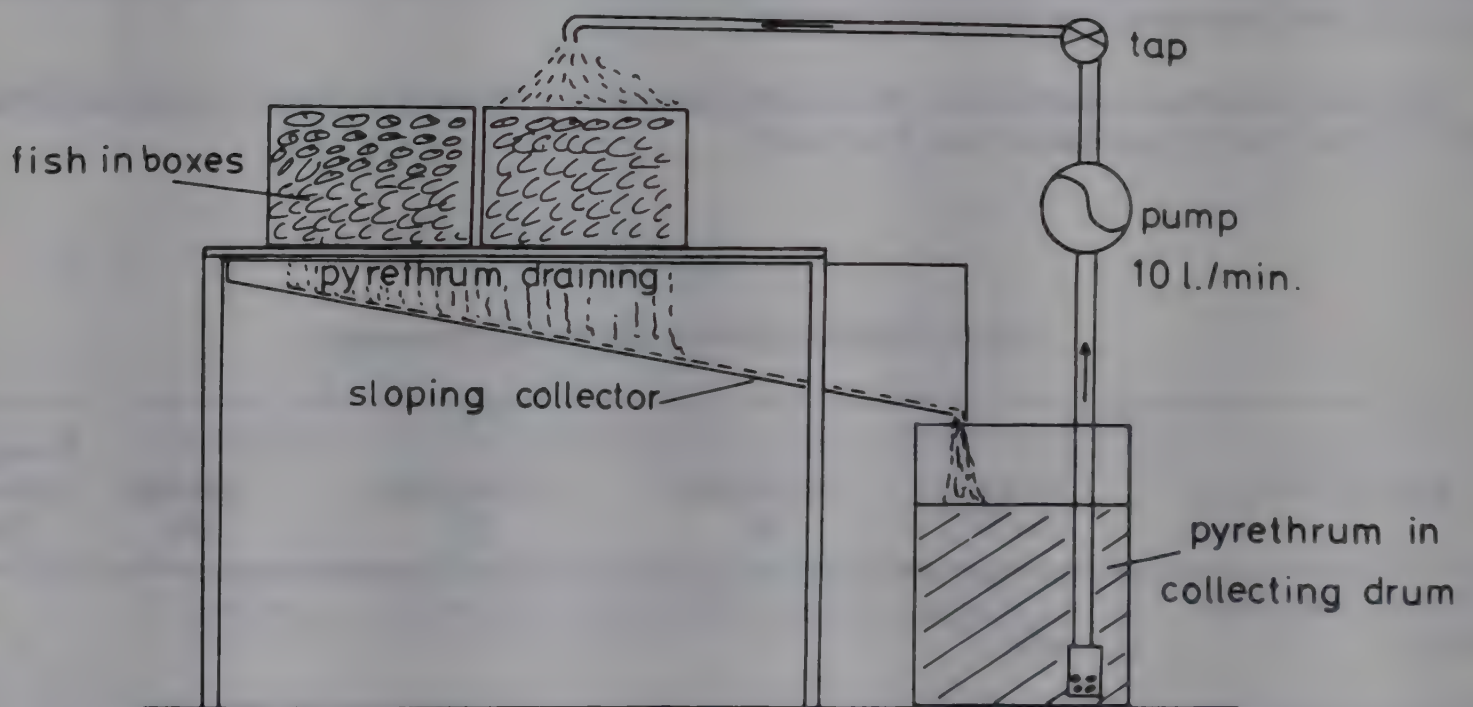


Fig. 2 — Scheme for recirculation system soaking fish with Pyrethrum.

The volume applied in the soaking technique is important; it has been found that 5-10 l of mixture per box will treat about 80 percent of the fish. This volume can be applied in a half to three quarters of a minute per box, a rate which is workable in practice. However, the soaking technique leaves some fish untreated and these will be prone to blowfly attack. The blowflies seem to actively seek out the untreated fish. As greater volumes are applied, the soaking method becomes equivalent to dipping and its effectiveness increases. Current work is aimed at comparing these two methods by bioassay and residue analysis.

EXPERIMENTAL FINDINGS

The insecticide used is a natural pyrethrum extract mixed at a 5 percent active ingredient concentration with its synergist, piperonyl butoxide, in a non-ionic emulsifier. This concentrate is diluted with water before application. One set of experiments was carried out to test the effectiveness of different formulation ratios of pyrethrum to synergist. In previous work formulations varying between 1:1 and 1:10 were used, but the higher ratios are not favoured for these trials because of the resulting high residues of the synergist. A 1:2 ratio was considered the maximum which would give residues below the WHO standards; three ratios, 1:0, 1:1, 1:2 were tested by bioassay. Fig. 3 shows the effectiveness of the different formulations at different concentrations, and Table 2 summarizes the synergistic effect of piperonyl butoxide. In all subsequent work the 1:2 formulation has been used.

Table 2

Efficiency of different formulation ratios in synergising pyrethrum

Formulation ratio Pyrethrum: piperonyl butoxide	Day 1 egg batches = Repellency	Total egg batches = Repellency	Total maggot batches = Repellency + Toxicity
1:0	1.0	1.0	1.0
1:1	1.26	1.21	0.98
1:2	2.22	1.86	1.36

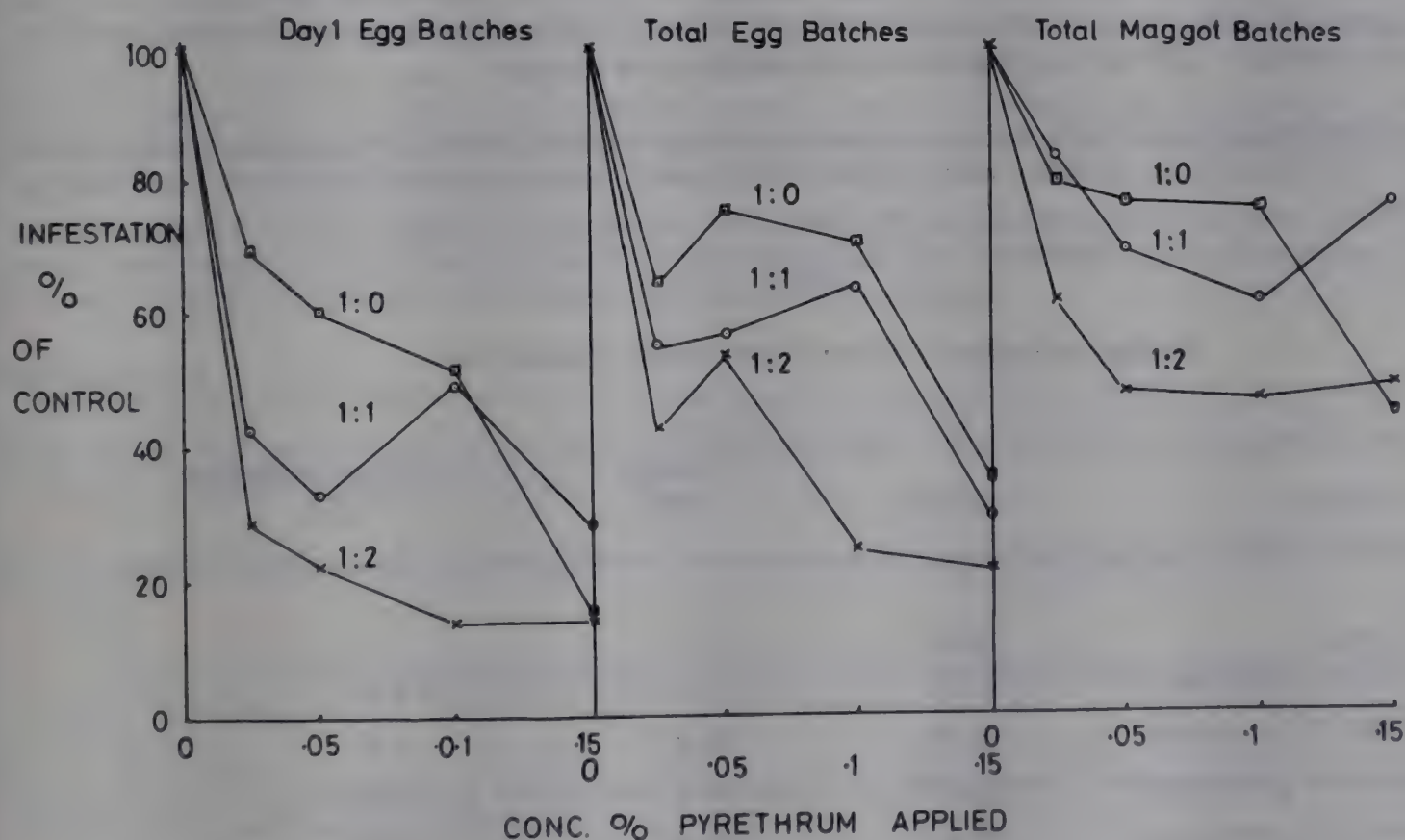


Fig. 3 — Bioassays of different concentrations and formulations of Pyrethrum in protecting drying fish against blowflies. Formulation ratios used of Pyrethrum: Piperonyl Butoxide 1:0 (□-□), 1:1 (o-o), 1:2 (x-x)

Fig. 3 also gives an indication of the minimum effective concentration of pyrethrum. In this experiment, the lowest concentration used, 0.025 percent, was effective at controlling blowfly activity; above 0.05 percent the effect levels off. Other experiments at lower concentrations showed that there is a steady decrease in effectiveness, which is not acceptable, below about 0.02 percent pyrethrum.

One constraint upon the use of pyrethrum in this method is the residues of both pyrethrum and piperonyl butoxide in the dried fish; as the fish dry out, the concentration within them increases. Although the residue analysis has not yet been completed, preliminary results indicate that the maximum concentration using the 1:2 formulation lies between 0.05 percent and 0.1 percent. At this level the residues in the fish will be below the 3 ppm and 20 ppm recommended levels for pyrethrum and piperonyl butoxide. However, Fig. 3 shows that these concentrations will give almost maximum protection.

A number of semi-commercial runs have been carried out to obtain the approximate costs and procedures involved. In all of these, the soaking method has been used, dosing 6 l of 0.033 percent pyrethrum (1:2 formulation) per 60 lb box of fish. With each box the solution becomes more dilute and eventually the concentration becomes so low that the effectiveness of the insecticide is lost, i.e., below about 0.02 percent. It is important, therefore to establish the number of boxes a given volume of mix can treat before it is exhausted; this will determine the cost of the treatment.

With 30 l of a 0.033 percent mix the fall in the effectiveness, as measured by the bioassay, could be related to the number; after treating 60 boxes, the mix was becoming exhausted. It is thought that the working volume allowance for recirculation at this concentration is about 0.5 l per box, but this will need to be checked by analysis of the pyrethrum remaining in the mix.

However, the life of the mix may also be determined by the general contamination from the boxes of fish. The fish were washed before treatment but, after 60 boxes had been treated, the fish had a distinct yellow colour and the bacterial numbers on the skin increased about 100 times. Coliforms, faecal streptococci and anaerobic sulphite reducers are similarly increased. This rather frightening picture is modified when the fish are dried and there seems little difference in bacterial numbers on untreated and treated fish. It is probable that sun-drying exposes the fish to far greater contamination from dust, flies and handling, etc. than any introduced by this form of treatment. This aspect obviously requires further investigation.

The practical significance of the soaking method was evaluated from both experimental and semi-commercial runs. The DWY% and the wastages were estimated for several concentrations of pyrethrum, and these are shown in Table 3.

Table 3

Wastage estimates at different pyrethrum concentration

Treatment	DWY%	Wastage (%)	Wastage reduction (%)
Control	20.02	43.3	—
0.01 % pyrethrum	21.74	37.3	6.0
0.017 % pyrethrum	22.00	36.4	6.9
0.025 % pyrethrum	23.21	32.1	11.2
0.033 % pyrethrum	24.66	26.3	17.0

These results complement the bioassay findings, and show that the minimum effective concentration to give significant reduction in wastage lies between 0.017 percent and 0.025 percent. The semi-commercial runs also showed that, even after 60 boxes had been treated, some reduction in the wastage could still be obtained. Although the insect infestation and thus the wastages varied with the weather during these runs, the overall

reduction in wastage was found to be 7.9 percent with an increase in DWY% of 2.3 percent. If all the fish dried in 1975-76 and 1976-77 rainy seasons had been treated, the wastage due to blowflies might have been reduced from 26.6 percent and 10.3 percent to 18.7 percent and 2.4 percent respectively.

COSTS VERSUS BENEFITS

The cost of locally available pyrethrum and piperonyl butoxide is 19 Kwachas per litre (K1 is approximately equivalent to U.S. \$ 1). When used at a concentration of 0.033 percent, 25 l of mix would cost K3.20 or 6.4 tambalas per box (K1.00 = 100 tambalas if 50 boxes are treated. The wet fish cost K1.50 for 60 lb and, when dried, they are sold at 15-20 tambales per lb. A 60 lb box of fish when dried yields 17.1 lb and will realize between K1.00 and K2.00 profit. If the decrease in wastage through the use of pyrethrum is 7.9 percent, the weight saving will be 1.33 lb of dried fish per box. At 15 tambalas per lb the monetary saving will be 20 tambalas, which is more than adequate to cover the cost of 6.4 tambalas per box for pyrethrum treatment.

CONCLUSIONS

From this brief summary of some of the findings from the work to control blowflies on drying fish, it can be seen that the method is effective and does give some real reduction in the wastage of fish in Malawi, both in quantity and monetary value. There remains a number of questions which still have to be answered before the method can be put forward with final recommendations. First of these is whether the soaking method can be improved so that all the fish can be protected; this may involve using greater volumes or higher concentrations of mix. The dipping method may be found to be the best in the end provided that the residues in the final product lie within the accepted limits.

The question of bacterial contamination and possible health hazard from using this form of treatment needs very careful investigation if large numbers of boxes are to be treated together. The other benefit which this treatment may produce is to give some protection against *Dermestes* beetles during the storage of the dried fish, although preliminary results indicated that only little protection was afforded, this needs confirmation.

The work is still in progress, and some of these questions should have been answered by the end of this coming rainy season. The method can then be tried out in the field; the ultimate test of its success. Before this, however, the work will be reported in greater detail in the scientific press.

REFERENCES

- Green, A.A., The protection of dried sea fish in South Arabia from infestation by *Dermestes frischii* (Krug).
1967 *J.Stored Prod.Res.*, 2:331-50
- McLellan, R.H., The use of a pyrethrum dip as a protection for drying fish in Uganda. *Pyrethrum Post*, 7(1):8-10
1963
- _____, A pyrethrum dipping treatment to protect dried fish from beetle infestation. *Pyrethrum Post*,
1964 7(3):30-3
- Proctor, D.L., The protection of smoke dried freshwater fish from insect damage during storage in Zambia.
1972 *J.Stored Prod. Res.*, 8:139-49

HANDLING AND PROCESSING OF RAFT-FARMED MUSSELS

by

N.S. Boyd and N.D.C. Wilson
Massey University
New Zealand

Abstract

This paper describes the handling and processing of farmed mussels with special reference to keeping mussels alive out of water and to the freezing of shucked mussels.

It was possible to increase the time mussels remain alive out of water from 3 days at ambient temperatures to over 2 weeks with the use of ice and specially designed cardboard boxes.

Unless adequately blanched, mussels develop strong off-flavours within 2 weeks of frozen storage. Off-flavour development can be prevented by using adequate heat treatment; overheating results in a considerable loss of weight and toughening of the meats.

The shelf-life of blanched, frozen and glazed mussel meats is greater than 9 months at -30°C .

INTRODUCTION

Farming the green-lipped mussel, *Perna canaliculus*, is a rapidly growing industry in New Zealand. The expected crop from the main growing area in the Marlborough Sounds for the 1977/78 season is 500 t, rising to 5 000 t in five years' time.

For many years, small quantities of this mussel have been collected by bottom dredging. Although the flavour of the dredged mussel is similar to the farmed product, its texture is very tough and rubbery and parts of it, such as the adductor muscle, are so tough as to be inedible. The farmed mussel, however, probably because of its fast growth rate, has a much softer texture and its quality is such that it is able to compete with other shellfish such as oysters and scallops.

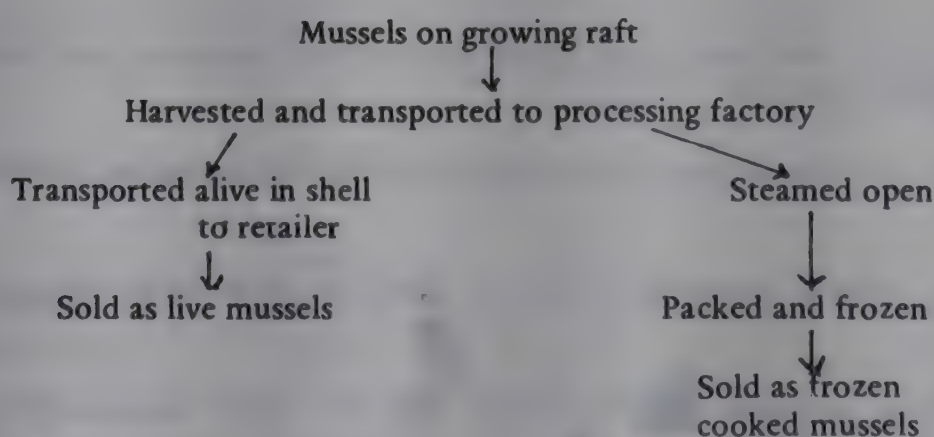


Figure 1. The main outlets for farmed mussels

The industry has two main outlets for the product (Fig. 1). Much of the present production is sold fresh in the shell; the live mussels (shellstock) are packed into sacks or cartons and sent direct to the retailer. Increasing quantities are now being steamed open and frozen in catering and retail packs. This paper looks at the handling and processing requirements for maintaining the quality of mussels destined for both of these markets.

METHOD

Handling shellstock

A taste panel score sheet has been prepared to assess the freshness of mussels (see Appendix); the mussels are scored for odour, texture and flavour on a scale from 5 for very fresh mussels to 0 when almost inedible. This score sheet was used to determine the rate of spoilage of shellstock under the following conditions:

- (i) packed in ice
- (ii) held in air at ambient temperatures (15-18°C)
- (iii) held in a chillroom at temperatures between 5 and 7°C and relative humidity greater than 95 percent
- (iv) held under melting ice at temperatures between 2 and 3°C after the method described by Rama and Metamoros (1973).

Six mussels from each treatment were taken every 24 h, steamed open and submitted to the taste panel for evaluation.

Steaming open shellstock

Fresh mussels weighing between 45 and 55 g were opened by heating with live steam at atmospheric pressure for periods of 2, 3, 5, 7, 9 and 10 minutes. The weight loss of the mussel meat during cooking was expressed as follows:

$$\frac{\text{whole mussel} - (\text{shell} + \text{cooked meat})}{\text{whole mussel} - \text{shell}} \times \frac{100}{1} = \% \text{ weight loss}$$

Organoleptic quality was measured using the taste panel score sheet given in the Appendix; aerobic bacterial counts of the cooked meats were made on nutrient agar incubated at 25°C. In addition, samples were also frozen and stored at -20°C without protective packaging. After 1 and 2 months storage these samples were heated over a water bath in a covered casserole dish and evaluated organoleptically.

Frozen storage

Fresh mussels which had been steamed open for 5 min were frozen, glazed in ice water and stored at -20 and -29°C. After 1, 3 and 10 months, the quality was determined as above.

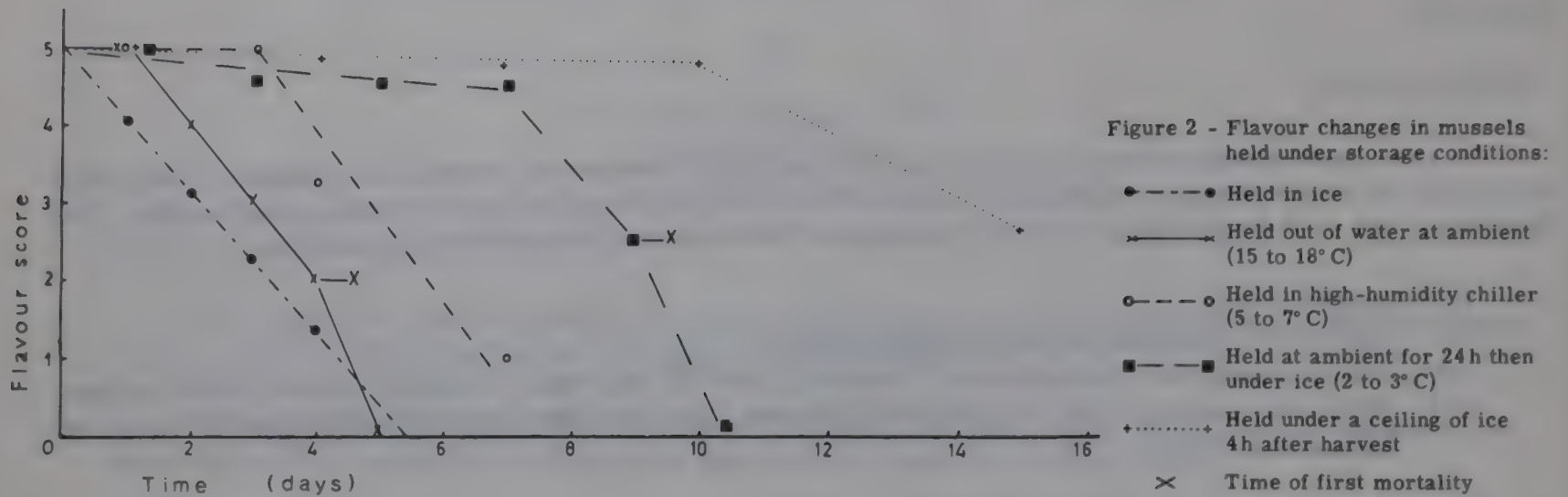
RESULTS AND DISCUSSION

Handling shellstock

The loss of flavour of mussel shellstock after removal from the water is shown in Fig. 2. Mussels that had been packed in ice dried very quickly and showed the most rapid loss of flavour. If the quality level acceptable for processing is established at grade 3, the point at which definite off-flavours begin to appear, then iced mussels have a shelf-life of only 2 days.

For mussels held at ambient temperatures (15-18°C), the first mortality occurred after 4 days. Noticeable loss in flavour occurred after only 2 days and the minimum quality grade of 3 was reached after 3 days. It is commonly believed that providing mussels are alive they are of premium quality. This is clearly not the case.

Chilling the mussels to between 5 and 7°C extended the time before flavour losses were detectable to three and a half days; they became unacceptable after five days. Mussels held under ice at temperatures between 2 and 3°C showed the largest increase in shelf life. When chilling by this method was delayed for 24 h after harvest, the quality remained above grade 3 for eight and a half days and the first mortality was observed after nine days. When chilled 4 h after harvest, the mussels remained alive and above grade 3 for fourteen days.



Steaming open shellstock

Changes in percentage weight loss, bacterial numbers and textural quality with steaming time are shown in Fig. 3. The percentage weight loss of the mussel meats during steaming was 25 percent after the first 3 min with a gradual increase of 34 percent after 7 min. The rate of loss increased further when the cooking times were extended beyond 7 min. During the first 3 min of steaming there was 95 percent reduction in bacterial numbers. Extending steaming times to 10 min produced little further improvement.

Mussels require some heat treatment to prevent rapid loss of quality during frozen storage. Overcooking results in excessive weight loss and adverse textural changes. For the size of mussel used in these experiments, a steaming time close to 5 min appears to be the optimum.

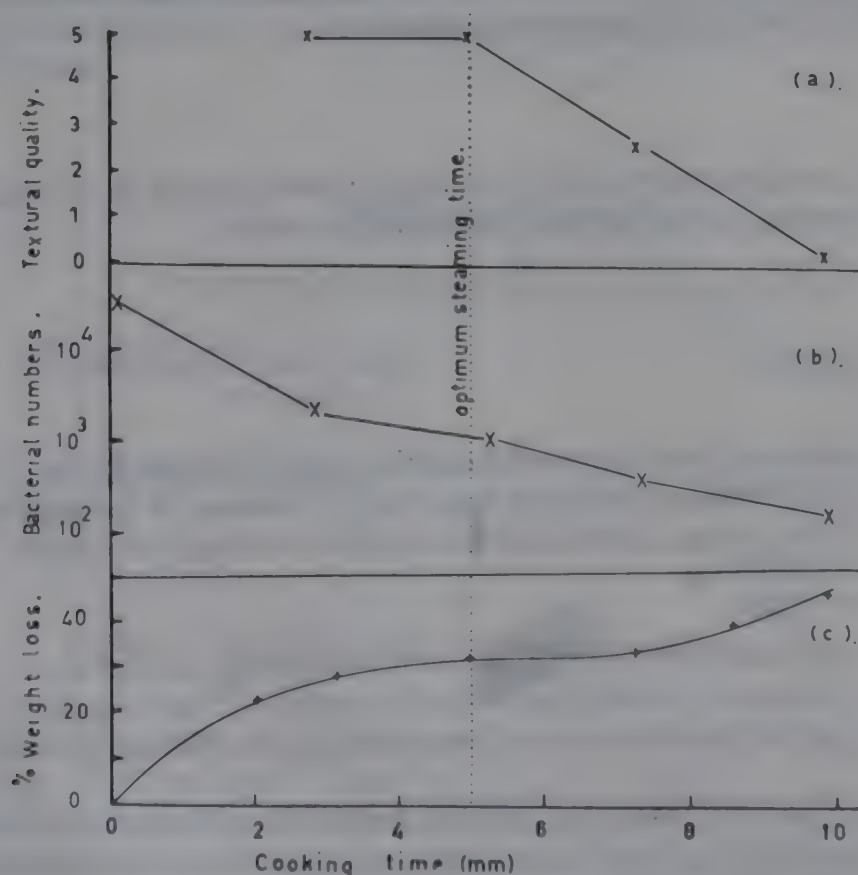


Figure 3 — Changes in textural quality, bacterial numbers, and percentage weight loss with steaming time

Frozen storage

Table 1 shows the effect of cooking time on organoleptic quality after 1 and 2 months' frozen storage at -20°C . The uncooked mussels and those cooked for only 3.5 min showed a rapid loss in odour and flavour compared with those cooked for 5.5 min. The mussels cooked for 9.5 min showed an initial quality loss due to overcooking but the scores remained almost constant over the 2 months' storage period.

The loss of quality during frozen storage at -20 and -29°C is shown in Table 2. At -29°C the lower limit of acceptability for odour and flavour is reached after only 3 months' frozen storage; at -25°C this level is reached after 10 months. Banks and House (1958) recommended a storage life of 9 months at -29°C . Commercial storage times of 6 months or longer are often required; this can be achieved only by storage at the lower temperature.

Table 1

Quality changes of mussels steamed for various lengths of time during storage at -20°C

Steaming time (min)	0		3.5		5.5		9.5	
Storage time (months)	1	2	1	2	1	2	1	2
Odour	0	0	2	1	4	3.5	3	3
Texture	3.7	a/	4.5	4	4.5	4	3.5	3.5
Flavour	2	a/	3	2	4.5	4.5	3.3	3.2

a/ Panel unwilling to taste

Table 2

Loss of quality during frozen storage of mussels

Time (months)	1		3		10	
Temperature ($^{\circ}\text{C}$)	-20	-29	-20	-29	-20	-29
Odour	4	4.5	3	4	0	3
Texture	4	4	4	4	a/	3.5
Flavour	4.5	5	3	4	a/	3

a/ Panel unwilling to taste

CONCLUSIONS

- (1) Shellstock held for longer than 24 h out of water should be chilled as soon as possible after harvest by being held under ice.
- (2) Carefully controlled cooking times are required to maintain texture and to prevent excessive weight and flavour losses during frozen storage. Uncooked mussels cannot be held in frozen storage.
- (3) Frozen storage of mussels for longer than 3 months should be at -29°C .

ACKNOWLEDGEMENT

The work described in this paper was carried out as part of the research programme sponsored by the Fishing Industry Board.

REFERENCES

- Banks, A. and C.T. House, The freezing and cold storage of mussels. *Mod.Refrig.*, 61(724):686-8
1958
- Rama, A.M. and E.G. Matamoros, Simulated experimental transport of live mussels (*Mytilus edulis*) in a nitrogen
1973 atmosphere. Proc. I.I.R. Comm., D1, D2, D3, Barcelona

*Appendix**Mussel score sheet*

Cooked odour

Score

- 5 Fresh mussel, salt water, little odour
- 4 Mild, buttery, milky, thick smell
- 3 Slightly sweaty, old socks
- 2 Rubbery, strong sweaty smells
- 1 Bland, rubbery pumpkin
- 0 Faecal, vomit, nauseating

Cooked texture

Score

- 5 Soft and juicy
- 3 Drier, juice runs out on chewing
- 0 Tough and rubbery

Cooked flavour

Score

- 5 Characteristic mussel flavour, sweet
- 4 Slight fishy, briney sweet
- 3 Strong briney, sea-water after-taste, scallop
- 2 Strong mussels, slightly sweaty
- 1 Strong mussels, sour after-taste, cabbagey
- 0 Difficult to taste, nauseating

ADAPTATION OF THERMAL PROCESSING TO DEVELOP PRODUCTS FROM SMALL FISH

by

197
R. Balakrishnan Nair and A.K. Chatterjee
Central Food Technological Research Institute
Mysore, India

Abstract

A technique for conditioning small bony fish to make them suitable for a variety of ready-to-use convenience products has been developed. The technique involves subjecting the dressed fish, after suitable pretreatments, to controlled thermal processing. The choice of fish, pretreatment and conditions of processing depends on the end product desired. Full yield is assured in the process since it eliminates filleting or deboning. The product has a delicate flavour and retains the basic muscle texture. Products such as breaded fish, cutlets and frozen curried blocks have been formulated from the thermal by processed fish. A few dehydrated products conforming to Indian tastes have also been developed. The products have been shown to possess a shelf-life exceeding six months.

INTRODUCTION

The pattern of present fish landings in India, and that projected for the future, shows a predominance of pelagic fish, especially of the smaller species, the utilization of which poses certain problems (FAO, 1975; Blindheim *et al.*, 1975). Only a few are suitable for traditional processing such as salt-curing. Small size and the presence of many bones are inhibiting factors in their use. There is thus a need to divert as much of these catches as possible to the newer and ever-growing urban market in the form of products which conform to the changing consumer pattern. These products may be unconventional but must suit the local food habits and must be moderately priced. The process discussed here aims at creating a range of such products, in which low-cost raw materials are used, employing techniques which are easily adaptable in any conventional fish processing factory. These techniques represent known processing operations, suitably adapted with appropriate innovations to develop different end products.

MATERIALS AND METHODS

Fish such as *Sardinella*, *Clupea*, *Sciaenidae*, *Stolephorus*, etc. were used. The choice of fish depended on the end product desired, determined mainly by muscle texture and fat content.

Preparation of raw material

The fish were beheaded and the viscera, scales and fins were removed. The fish were treated with 10-15 percent brine for 10-15 minutes, the exact conditions depending on the size of the fish and the extent of salting needed. Four percent acetic acid was used with the brine when a firm texture was desired. The fish were then subjected to thermal processing.

Thermal processing

The fish were processed under steam pressure; the conditions of processing were governed mainly by the size of the fish. Generally, for fish 7 inches or less in length a processing temperature of 120°C, and a duration of 1 hour, were found to give the desired results. The objective was to achieve optimum texture and flavour and complete softening of the bone. For products which required a lower moisture content, the processing could be carried out in steam (1 hour at 120°C) with arrangements for drainage of the drip. For those products in which the fish were comminuted or slurried, brine could be used advantageously.

PRODUCT FORMULATION

The thermally processed fish were in a form which could be incorporated directly into different recipes or could be stored in frozen condition. The preparation of a variety of products developed from thermally processed fish is shown in the flow diagram (Fig. 1).

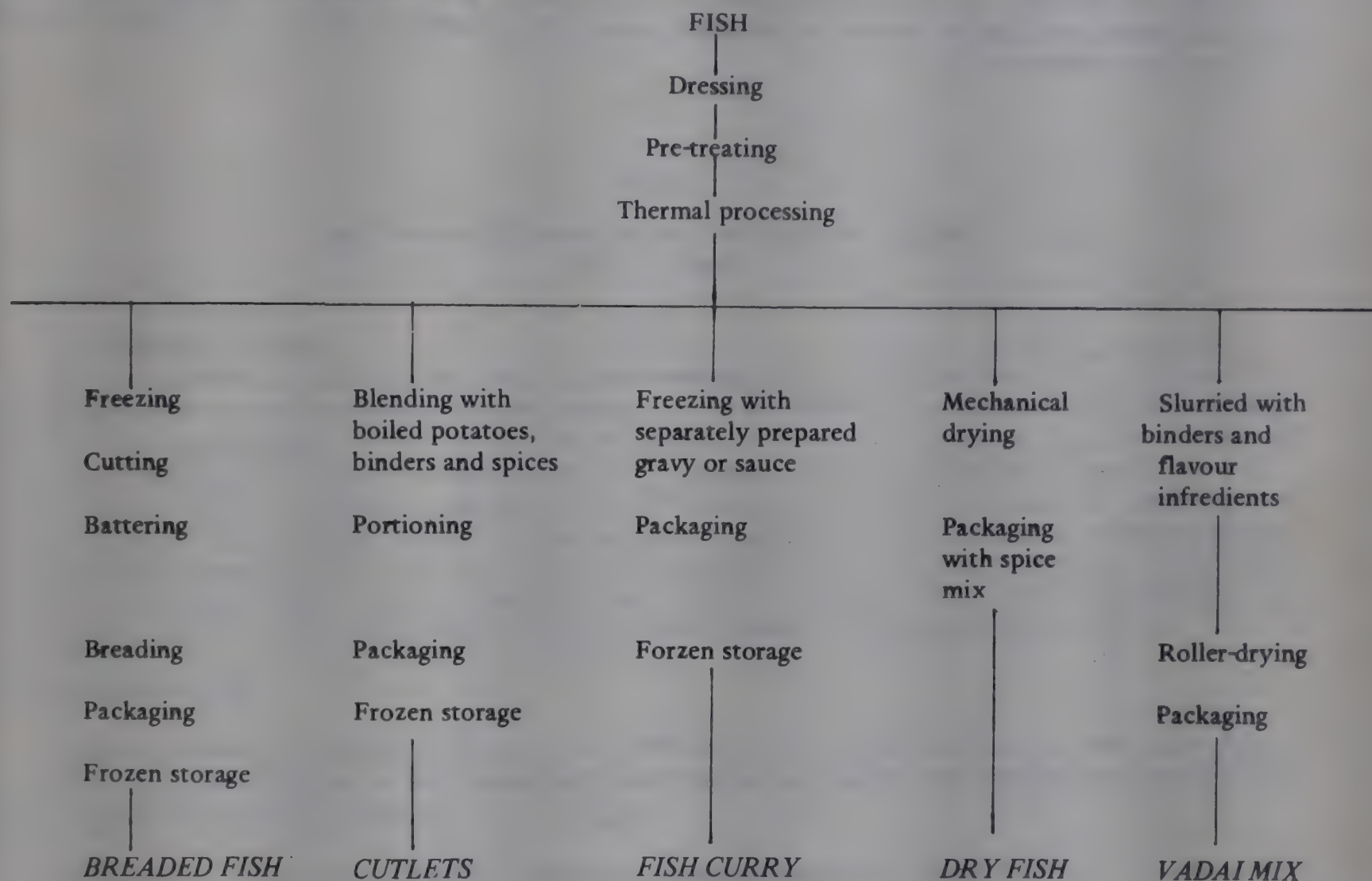


Figure 1. Flow diagram for the thermally processed products

EVALUATION OF QUALITY AND SHELF-LIFE

The quality of the thermally processed fish was evaluated by the Sensory Evaluation Group of the Institute. Flavour and texture characteristics were compared with conventionally cooked fish and canned fish using paired difference tests. Lipid changes in the frozen stored thermally processed fish and some of the products developed were determined by the measurement of free fatty acids and thiobarbituric acid number (Tarladgis, *et al.*, 1960). Spoilage was measured by total volatile bases and total bacterial count (Moorjani *et al.*, 1958). The overall quality of the stored products was evaluated by a panel of members of the laboratory.

RESULTS AND DISCUSSION

Probably the most significant factor in favour of thermally processed products is the retention of the entire edible part of the fish in the finished products. This is achieved by softening the bones without sacrificing the basic muscle texture and flavour (to be discussed later). This may be compared with filleting where the yield is very poor for these species, or with deboning where the basic muscle texture is impaired.

Results of the sensory evaluation of the thermally processed fish showed a significant difference from conventionally cooked fish or canned fish. While there was a slight preference in favour of thermally processed fish over conventionally cooked fish, there was a significant preference over canned fish with regard to texture and flavour.

Rancidity development is the main deteriorative change in frozen stored or dried fish products. This type of spoilage was not very significant in the products tested (Tables 1, 2, 3). This agrees with earlier reports that rancidity development may be retarded in pre-cooked meat or fish products (Edithweir *et al.*, 1960). However, this aspect needs further study

Table 1

Changes occurring in the lipids of thermally processed fish
stored at -10°C

Days of storage	% FFA (as oleic acid)	TBA No. (mg malonaldehyde/ 1 000 g)
0	0.69	0.38
7	1.20	0.63
15	1.10	0.43
30	1.40	0.84
45	1.40	0.87
60	1.39	1.05
90	1.26	0.78
180	1.40	1.40

Table 2

Quality of thermally processed fish stored at -10°C by chemical
microbiological and organoleptic means

Months of storage	TVB (mg/100 g)	TBA No.	Total bacterial count (per g)		Organoleptic quality
			Unbreaded samples	Breaded samples	
0	9.8	1.2	170	3.2×10^3	good
1	9.8	1.4	—	—	good
2	16.8	1.9	—	—	good
3	19.6	2.0	70	1.4×10^4	good
4	22.4	1.2	—	—	good
5	24.7	1.2	—	—	good
6	22.4	1.2	150	4.1×10^3	good

Table 3

Changes occurring in the lipids of the roller-dried product during cold storage (-10°C)

Months of storage	TBA No.	Organoleptic quality
0	0.32	good
1	0.14	good
2	0.39	good
3	0.21	good
4	0.43	good
5	—	good
6	0.51	good

Spoilage in terms of total volatile bases also appears to be well within acceptability limits for the period of storage studied. It may be noted that the total bacterial count of the unbreaded samples was insignificant throughout. The bacterial population in the final product was affected by the other ingredients, e.g., batter. However, this figure is within the limits reported for commercially processed fish sticks (Peterson *et al.*, 1968).

The bacteriological quality of a laboratory product of this type is no indicator of bacterial safety in a commercial product. A pre-cooked product presents dangers of contamination by pathogenic organisms through subsequent handling operations. Absence of microbial competition is an added danger (Peterson *et al.*, 1968). Hence, the adherence to strict hygienic measures is an essential prerequisite for the commercial production of this type of product. Proper packaging of the finished product is also an essential aspect in this regard.

ACKNOWLEDGEMENT

The authors are grateful to Mr. V.S. Govindarajan and Mr. A. Dhanraj for their assistance in sensory evaluation. They also wish to thank Dr. M.N. Moorjani, Project Coordinator and Dr. B.L. Alma, Director, for many useful suggestions during the investigation.

REFERENCES

- Blindheim, J., D. Chakraborty and M. Devidas Menon, Proceedings of the Symposium on fish processing industry 1973 in India Mysore
- Edithweir, C. *et al.*, Food Research, 25, 120 p. 1960
- FAO, Yearbook of fisheries statistics. Catches and landings. *FAO Yearb. Fish. Stat.*, (38):pag.var. 1975
- Moorjani, M.N. *et al.*, *Food. Technol.*, Champaign, 12, 385 p. 1958
- Peterson, A.C., M.J. Fanelli and M.F. Gudnerson, The freezing preservation of foods. Vol. IV. Ed. D.J. Tressler 1968 *et al.*, 57p.
- Tarladgis, B.G. and M.T. Jounathan. A distillation method for the quantitative determination of malonaldehyde 1960 in rancid foods. *J. Am. Oil Chem. Soc.*, 1960:37-45

STUDIES ON THE UTILIZATION OF FISHERY WASTES FOR THE PRODUCTION OF MICROBIOLOGICAL MEDIA

by

S.V. Suryanarayana Rao, C.R. Saraswati and C.T. Dwarakanath
Central Food Technological Research Institute
Mysore, India

Abstract

The preparation of peptones as microbiological media from fish muscle and fish waste has yielded promising results. One of the samples, prepared from the heads and viscera of freshwater fish, was found to be equal to oxoid bactopectone in growth promotion of organisms with stringent requirements such as *Lactobacillus arabinosus* and *Streptococcus faecalis*. Papin treatment at 40°C for 4 hours followed by vacuum drying gave a pale yellow hygroscopic product containing 20.4 percent of amino Nitrogen. A method which relies on autolysis could be adopted for certain types of waste such as mackerel waste which has a high proteolytic activity.

INTRODUCTION

Since Tarr (1948) suggested that it would be possible, and perhaps cheaper, to obtain peptones from fish and fishery wastes test, several reports have appeared in the literature on the usefulness of fish peptones as microbiological media. Fish muscle proved to be a suitable substitute for meat as pointed out in a previous communication from this Institute. The present authors have shown fish wastes to be equally effective; they provide a cheap raw material and help in by-product utilization. Recovery of protein from fishery wastes in the form of hydrolysates is of particular significance in developing countries since fishery wastes are at present largely unutilized or are, in some cases, converted into manure. It is however known that they could be converted into hydrolysates as in the STP Process (1951) based on autolysis, or by enzymatic, digestion as described by Mackie (1974).

In continuation of the earlier work carried out at this Institute on fish hydrolysates, preparation of microbiological media has shown promising results. One of the samples prepared from the head and visceral portion of freshwater fish was found to be equal to beef peptone in growth promotion of organisms with stringent requirements such as *Lactobacillus arabinosus* and *Streptococcus faecalis*. Papain treatment was adopted for the above experiments. Data for samples obtained solely by autolysis of mackerel waste are also presented.

EXPERIMENTAL

Material and methods

Apart from preliminary work dealing with mackerel (*Rastrelliger kanagurta*), filleting waste from freshwater fish *Barbus carnaticus* and other carps, e.g., rohu, calbasu, etc., was used for the preparation of hydrolysates described in this study. Each sample of fish waste was chopped with a heavy meat knife and chloroform was added to prevent microbial spoilage. Lots of 5 kg were transferred to a steel vessel and mixed thoroughly with water in a 1:1 ratio, an allowance in volume was made for the addition of papain suspension and pH adjustment. Papain was added at 0.1 percent level (weight of the raw material) to digest the material. The addition of activators such as cysteine and the disodium salt of EDTA, which were used in earlier experiments, was found to be unnecessary with the papain sample supplied by Enzo-chem. Lab., Yeola. The pH was adjusted to 5.0 in the earlier batch with 2N HCl, and enzymatic digestion was carried out at 55-60°C for two hours. Chloroform was again added before commencement. After the digestion period the material was heated quickly to boiling point and held at that temperature for 10 minutes to inactivate the enzymes. The hydrolysate was freed by coarse filtration and, after keeping overnight, was filtered with the addition of toluene, until a pale yellow, clear filtrate was obtained. After determination of total solids, the filtrate was reduced in volume by vacuum

concentration and finally dried in a vacuum shelf drier at 50-60°C. A second sample was prepared with neutral pH and a digestion time of four hours at 40°C. Samples of 50-100 cm³ were removed at intervals to follow the rate of proteolysis.

Chemical analysis

Total solids were determined by evaporating 20-25 cm³ of the clear hydrolysate over a water bath, drying in the oven at a low temperature and finally drying to constant weight in a vacuum desiccator. Total nitrogen was estimated, after digestion in a micro-Kjeldahl apparatus, on 10 cm of the filtrate or 0.5 g of the final product. Precipitation by saturation with zinc sulphate, as described in Winton and Winton (1955) was employed for the estimation of protein nitrogen. Primary protein N was estimated by half saturation with ZnSO₄. Free amino N was estimated in all cases by the Pope and Stevens method (1939). Fat content of the sample was estimated by petroleum ether extraction in a Soxhlet apparatus. Ash, calcium and phosphorus estimations were carried out according to the method of Nair and Godavari Bai (1975). Tryptophan was estimated after alkaline hydrolysis by Spies colorimetric method as described by Balasubramanian *et al.*, (1952).

Microbiological evaluation

Fish waste hydrolysate (Sample 2 in Table 2) was subjected to microbiological evaluation as a peptone substitute for its growth-promoting activity and compared with commercial peptone in an enriched mediums of the following composition:

Peptone	1.0 percent
Bacto yeast extract	0.2 percent
Glucose (anhydrous)	2.0 percent
Sodium acetate (anhydrous)	2.0 percent
Salt solution A ^{1/}	0.5 cm ³
Salt solution B ¹	0.5 cm ³
Distilled water	100.0 cm ³

This broth was boiled and the pH was adjusted to 7.0. It was finally filtered through Whatman No. 44 filter paper and 7 cm³ aliquots were sterilized in test tubes at 8.27 kPa for 15 minutes. Culture of *L. arabinosus* and *S. faecalis* were inoculated into the broth and incubated at 35°C for 18-20 hours. The cultures were then centrifuged and washed three times with sterile physiological saline (0.85 percent). The culture was resuspended in a known volume of sterile saline (5.0 cm³) and 0.05 cm³ inoculum added to each tube and incubated at 35°C for 24 hours. Samples were taken at intervals and the turbidity measured at 660 m u in a Spectronic 20 colorimeter. The data obtained were converted into optical density and are recorded in Fig. 1.

RESULTS AND DISCUSSIONS

It can be seen from Fig. 1 that the growth-promoting quality of the hydrolysate from freshwater fish waste is comparable, and even superior, to beef peptone for the test organisms. Lactobacilli were employed for the study since they are commonly used for the assay of amino acids and vitamins. They are also known for their stringent growth requirements. Results of the present investigation can be considered to be quite encouraging since earlier work on similar lines (Krishnaswamy and Lahiry, 1963) revealed lower quality as compared to commercial peptones; this was ascribed to nutritional deficiency or toxic factors. However, from the recent work of Stephens *et al.*, (1976), there is enough evidence of the usefulness of peptone from fish waste. Benchat (1974) has also described the preparation of peptone from catfish waste as a microbiological growth medium. Digestive organs of whale were also employed to obtain a peptone by Akiya *et al.*, (1949). Peptones from fish muscle were

^{1/} Barton-Wright (1950)

observed to be useful by several workers (Tarr and Deas, 1949; Smiszko *et al.*, 1950; Green *et al.*, 1973). Several processes have been described in the literature for the production of hydrolysates from fish and fish viscera (Toulec *et al.*, 1973; Nacoma, 1971). The present authors analysed samples from Japan and U.S.A. (Zapata Haynie Corp.) but it is not known whether these products are suitable as microbiological media; some of them are intended as milk replacers for calf feeding. Another objective of the current research work on fish hydrolysates is to make high-protein concentrates with better functional properties.

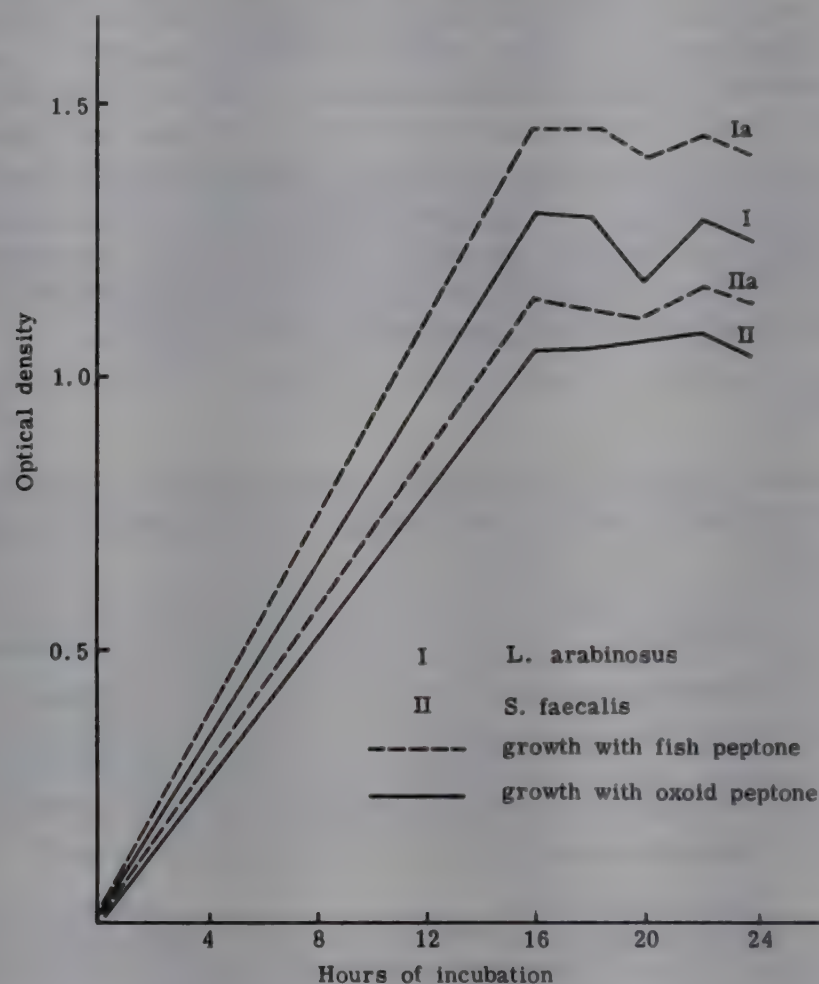


Fig. 1 — Growth promotion of test organisms by fish peptone and "Oxoid" peptone.

Table 1

Chemical composition and yield of the hydrolysate obtained from fish waste of marine and freshwater fish

Material	Treatment	Total solids (%)	Total yield (%)	Total N of product	Protein N g% of T.N.	δ -amino N g% of T.N.
Head and viscera of freshwater fish	With papain at 50°C and pH 7.0 for 2 hours	7.39	12.38	12.59	18.63	24.08
	Without papain	4.10	5.23	12.44	44.12	8.13
Viscera of mackerel	With papain at 50°C and pH 5.0	6.82	11.09	12.31	7.14	34.17
	Without papain	7.19	11.99	9.32	8.36	40.75

Regarding the process recommended for obtaining hydrolysates from fishery wastes, it may be observed from Table 1 that addition of papain is better than relying on autolysis since a much higher yield is obtained (12.38 percent as against 5.23 percent) with the addition of an extraneous enzyme. Judging from the values obtained for amino N by the Pope and Stevens technique (24.08 and 8.13 percent), the extent of hydrolysis appears to be improved for fish viscera with and without papain treatment. Higher proteolytic activity of the waste material as compared to muscle is, however, reflected in the data obtained during the study. Autolysis may be adopted for special cases like mackerel waste which was observed in a preliminary experiment to give the same yield (11.09 and 11.99 percent) with or without the addition of papain. It may be observed that, in spite of the equal yield, total nitrogen content of the product is lower in the absence of papain. Higher yields are also obtained when the enzyme concentration is increased from 0.1 to 0.2 percent (16.40 and 12.27 percent) but further work with greater homogenization of the raw material is needed to determine the optimum level of the enzyme on economic grounds. The same could be said regarding the time allowed for digestion. A minimum time of 2-4 hours was adopted during the study not only for economic reasons but also to conserve the nutritional quality and to minimize spoilage. Papain has been chosen for the preparation of hydrolysates for its wide range of activity and also for its capacity to liberate B-vitamins in the raw material.

A study of the chemical composition of the hydrolysates obtained from fishery waste, as recorded in Table 2, reveals that it compares favourably with the published data for commercial peptones. Whatever may be the special features, if any, for hydrolysates from fish muscle, tryptophan content merits attention for the present products obtained from fishery waste. Although it was slightly lower in one of the experimental samples, the same sample revealed good growth promotion in test organisms. It may therefore be adequate. It should be noted that one of the beef peptones marketed, i.e., peptone P-L49, is reported to contain only 0.33 percent tryptophan. Values for calcium and phosphorus content fall within the range described in the Oxoid manual. The fat content of the sample is slightly high but it is not known whether defatting is undertaken for commercial peptones. However, the medium prepared by using fish hydrolysate gave a clear solution during the study. Apart from the above data recorded for the experimental product, another point investigated in standardizing the processes adopted, was the possibility of utilizing cooked material for enzymatic hydrolysis; this would facilitate separation of bones and homogenizing the raw material. The rate of hydrolysis was much lower with cooked mince; the yield was 4.2 percent as against 9.16 percent under the same conditions.

Table 2

Chemical composition of hydrolysate from fish waste

Item	Sample 1	Sample 2	Beef peptone	Japanese ^a sample
	Digest at pH 5.0 for 2 hours at 50°C	Digest at pH 7.0 for 4 hours at 40°C		
Total N (%)	12.12	14.48	13.26	13.00
Primary protein N (% of total N)	4.06	5.95	6.25	—
Protein N (% of total N)	22.57	27.65	32.29	11.08
amino N (% of total N)	26.34	20.42	20.04	31.23
Ash (%)	6.08	—	—	—
Fat (%)	0.68	—	—	—
Tryptophan (%)	0.76	0.46	0.53	—
Ca (%)	0.046	—	0.143	—
P ₂ O ₅ (%)	2.75	—	2.6	—

a/ Japanese experimental sample from horse mackerel

Results obtained from these studies indicate that there is a wide scope for the preparation of hydrolysates, from fish wastes, which will be useful as microbiological media of high quality. Similar results of an encouraging nature have been obtained for a peptone substitutes recently prepared at this laboratory from shrimp waste on the above lines (Suryanarayana Rao *et al.*, 1971).

ACKNOWLEDGEMENT

The authors are thankful to Dr. M.N. Moorjani, Project Coordinator, Meat, Fish and Poultry Technology Discipline of this Institute and Dr. B.L. Amla, Director for their keen interest and helpful suggestions during the course of this investigation.

REFERENCES

- Akiya, S., S. Teshima and Y. Ishikawa, Symp. on Enzymol.Chem.(Japan), 3:43
1949
- Balasubramaniam, S.C. *et al.*, *Ind.J.Med.Res.*, 40:73
1952
- Barton Wright, E.C., Microbiological assay of vitamin B complex and amino acids, Pitman and Sons, London
1952
- Benchat, L.R., *J.Milk Food Techno.*, 37:277
1974
- Green, J.H. *et al.*, *Devl.Ind.Microbiol.*, 14:370
1973
- Krishnaswamy, M.A. and N.L. Lahiry, *J.Food Sci.*, 28:358
1963
- Mackie, I.M., *Process Biochem.*, December
1974
- Nacoma Co., France Peche 1971, p.32
1971
- Nair, M.R. and S. Godavari Bai, Methods of analysis of fish and fish products, CFTRI, Mysore
1975
- Pope, C.G. and M.F. Stevens, *Biochem.J.*, 33:1070
1939
- Snieszko, S.F., P.J. Griffin and S.B. Friddie, *J.Bacteriol.*, 59:699
1950
- Stephens, N.S. *et al.*, *App.and Environ.Microbiol.*, 31:1
1976

STP Process, French Patent 973700, 13 February
1951

Suryanarayana Rao, S.V., C.R. Saraswati and C.T. Dwarakanath, *Ind.J.Microbiol.* (in press)
1977

Tarr, H.L.A. and C.P. Deas, *J.Fish Res.Bd., Canada*, 7(a):552
1949

Toullec, R. *et al.*, *L'Alimentation. Vie*, 61:57
1973

Winton, A.L. and K.B. Winton, *The analysis of foods*. John Wiley and Sons, New York, Vol. II
1955

CHANGES IN TOTAL VOLATILE BASES DURING SALT PRESERVATION OF *SARDINELLA EBA* AND *CLUPEA HARENGUS*

by

M.B. Adebona
Department of Food Science and Technology
University of Ife
Ile-Ife, Nigeria

Abstract

This study was undertaken to investigate the production of volatile bases during salt preservation, and involved a comparison of three methods of salt preservation (brining, mixed salting and dry salting) and their effect on volatile amine production. An attempt was made to identify some of the components of the total volatile bases (TVB) using gas chromatography. Production of volatile bases was generally highest in brining and lowest in mixed salting.

The rate of TVB production increased with temperature and length of storage. The TVB produced during salt preservation consisted mainly of ammonia and, to a lesser extent, trimethylamine, dimethylamine and other unidentified components. More trimethylamine was produced in herring than in *Sardinella eba* during salt preservation.

INTRODUCTION

The volatile bases in fish tissues include ammonia and mono-, di-, and trimethylamine. They are present in small quantities in the muscle of fresh bony fish; only cartilaginous fish (shark and skate) have considerable amounts of these compounds. The trimethylammonium bases are found mainly in the muscle of marine fish (De Marindol, 1969).

It has been shown (Alm, 1965) that the total nitrogen content of fish decreases during curing. Alm also found that the non-protein nitrogen content of salt-preserved fish increased during storage up to 15 weeks. This finding was confirmed by the work of Govindan (1969) and Voskresensky (1965). Omland (1960) found that ammonia was the only nitrogenous compound which increased continuously during the storage of salt-cured fish. Total volatile nitrogen has been shown to increase, reaching a peak about the 25th day (Govindan, 1969); this increase is greatest toward the final stages of pickling and is indicative of spoilage changes.

In the present study, an attempt was made to investigate the production of volatile bases during salt preservation. The study compares three methods of salt preservation (brining, mixed salting and dry salting) and their effect on volatile amine production.

MATERIALS AND METHODS

Materials

Clupea harengus supplied from the Aberdeen (U.K.) fish market and *Sardinella eba* from Ghana were used. Other materials included fine-grained manufactured salt and 4-lb Kilner jars.

Methods

Three methods of salting (brining, mixed salting and dry salting) were used. The herring were gibbed, part of the gut removed (leaving the pyloric caeca) and cut transversely into two halves. Approximately equal weights of fish with about the same number of heads and tails were put into each jar. Salting was carried out as follows:

Brining — Saturated brine was added to about 900 g of herring in 4-lb Kilner jars. The volume required to almost fill each jar was noted.

Mixed Salting — About 200 g of salt was mixed with 900 g of fish and put in a kilner jar. Saturated brine was then added until the jar was nearly full and the volume of brine was noted.

Dry Salting — Each weighed sample of fish (about 900 g) was thoroughly mixed with about 350 g of salt. The salt/fish mixture was put into a Kilner jar and the residual salt was poured over the fish.

The jars were closed, labelled and stored at 2.2°C, 8°C, 25°C and 37°C for herring and 37°C for *S. eba*. To prepare the extracts, 100 g of the minced fish was put into an Atomix blender, 10 cm³ of 10 percent trichloroacetic acid or 0.6N perchloric acid solution were added and the mix was blended for about 1 min. The resulting mixture was filtered and the filtrate was stored under refrigeration until required.

Total Volatile Bases (TVB)

Total volatile bases were determined using the Hoskins distillation apparatus (Hoskins, 1944); 10 cm³ of 0.6N perchloric acid extract were transferred into the distillation apparatus, made alkaline with 10 cm³ of 20 percent sodium hydroxide and distilled into 5 cm³ of Sher's indicator. (Sher, 1955), containing 2 percent boric acid. About 20 cm³ of distillate were collected and titrated with 0.01N hydrochloric acid (1 ml of 0.01N HCL = 0.14mgN).

The steam distillate was analysed by gas chromatography (Mackir and Thompson, unpublished).

RESULTS

The changes in total volatile bases in the flesh during salt preservation are shown in Figs. 1 to 3. Production of volatile bases was generally highest in brining and lowest in mixed salting. Total volatile base production also increased with time and temperature. The effect of temperature on TVB production during brine preservation can be seen by comparing the final values obtained during the experiment. At 2.2°C TVB was 60 mg/100 g after 20 weeks; at 8°C it was 90 mg/100 g after 20 weeks; at 25°C TVB was 136 mg/100 g after 19 weeks; at 37°C TVB was 85 mg/100 g after 6 weeks. In *Sardinella eba* at 37°C TVB levelled off at about 130 mg/100 g after 4 weeks.

From Figs. 4 and 5 it can be seen that the TVB produced in *S. eba* preserved with brine at 37°C contained trimethylamine, dimethylamine and two unidentified components (x and y); herring preserved in brine at 37°C contained trimethylamine, dimethylamine and one unidentified component (x). The amount of trimethylamine produced in herring is about 11 times that produced in *S. eba* while the amount of component x produced in *S. eba* is about 14 times that produced in herring.

DISCUSSION

The results of this study show that total volatile bases increase during salt preservation. At lower temperatures (2.2°C and 8°C) the increase was most marked in brining and least in mixed salting. With increasing temperatures, the increases in TVB in brining and in dry salting were at about the same level. The rate of TVB production increased with time and temperature; Govindan (1969) and Omland (1960) also observed similar increases in TVB during the storage of salted fish. It has been suggested that the significant increase in TVB toward the final stages of salt preservation is indicative of spoilage changes.

Preliminary analysis of the volatile bases indicates that the major component was ammonia as was observed by Omland (1960). Other volatile basic components present (Figs. 4 and 5) include trimethylamine (TMA), dimethylamine (DMA) and two unidentified components. The concentration of TMA was considerably more in salt-preserved herring than in the *S. eba* while that of component x was much greater in *S. eba* than in herring.

ACKNOWLEDGEMENTS

This study was carried out at the Torry Research Station, Aberdeen. The author is indebted to Prof. J. Hawthorn and Dr. I.M. Mackie for their advice and help during the period of study.

REFERENCES

- Alm, F., Fish as food, Vol.III. Academic Press
1965
- De Merindol, A., Fish curing and processing, Fishing News Books (London) Ltd.
1969
- Govindan, T.K., *Indian Food Packer*, July/August, p. 18-22
1969
- Hoskins, H., *Analyst*, 69:271
1944
- Omland, D., FAO World Fisheries Abstracts, September/October, p. 35
1960
- Sher, I.M., Two step mixed indicator for Kjeldahl nitrogen titration. *Analytical Chemistry*, 27:831-2
1955
- Voskresensky, N.A., Fish as food, Vol.III, Chapter 3:p. 107
1965

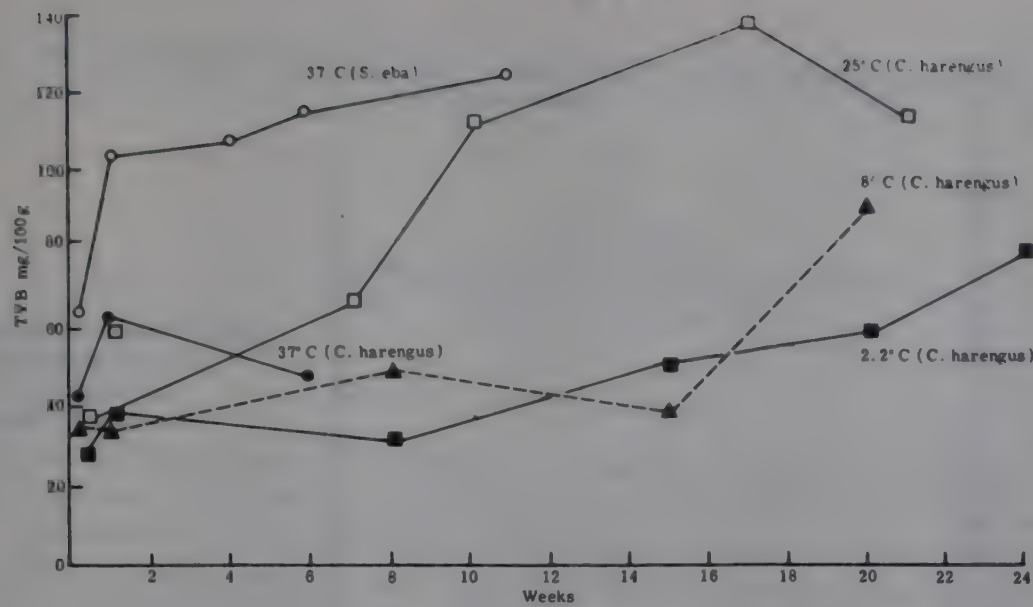


Fig. 1 - Changes in total volatile bases during brining

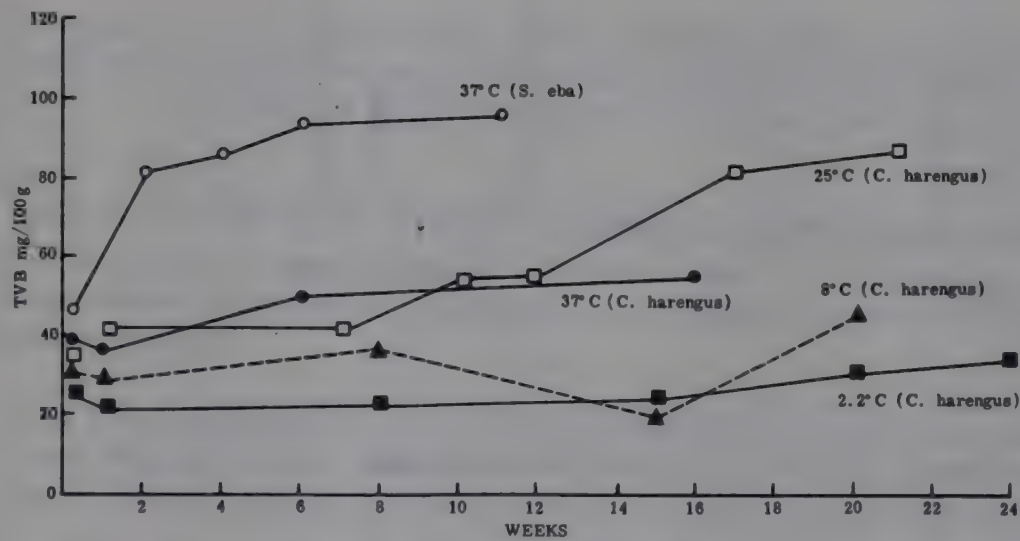


Fig. 2 - Changes in total volatile bases during mixed salting

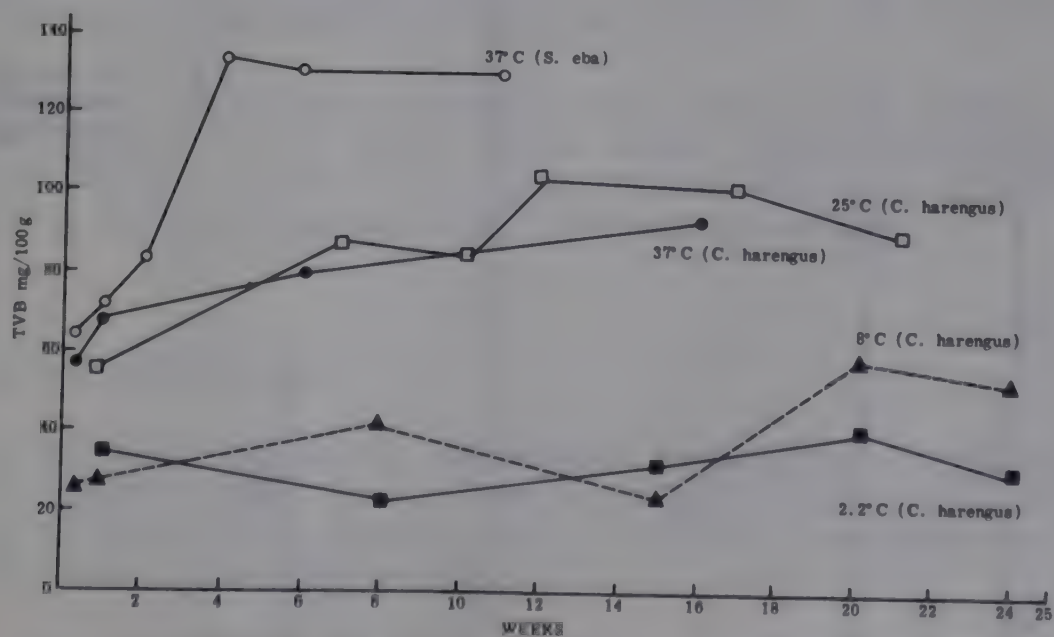


Fig. 3 - Changes in total volatile bases of *S. eba* and *C. harengus* during dry salting

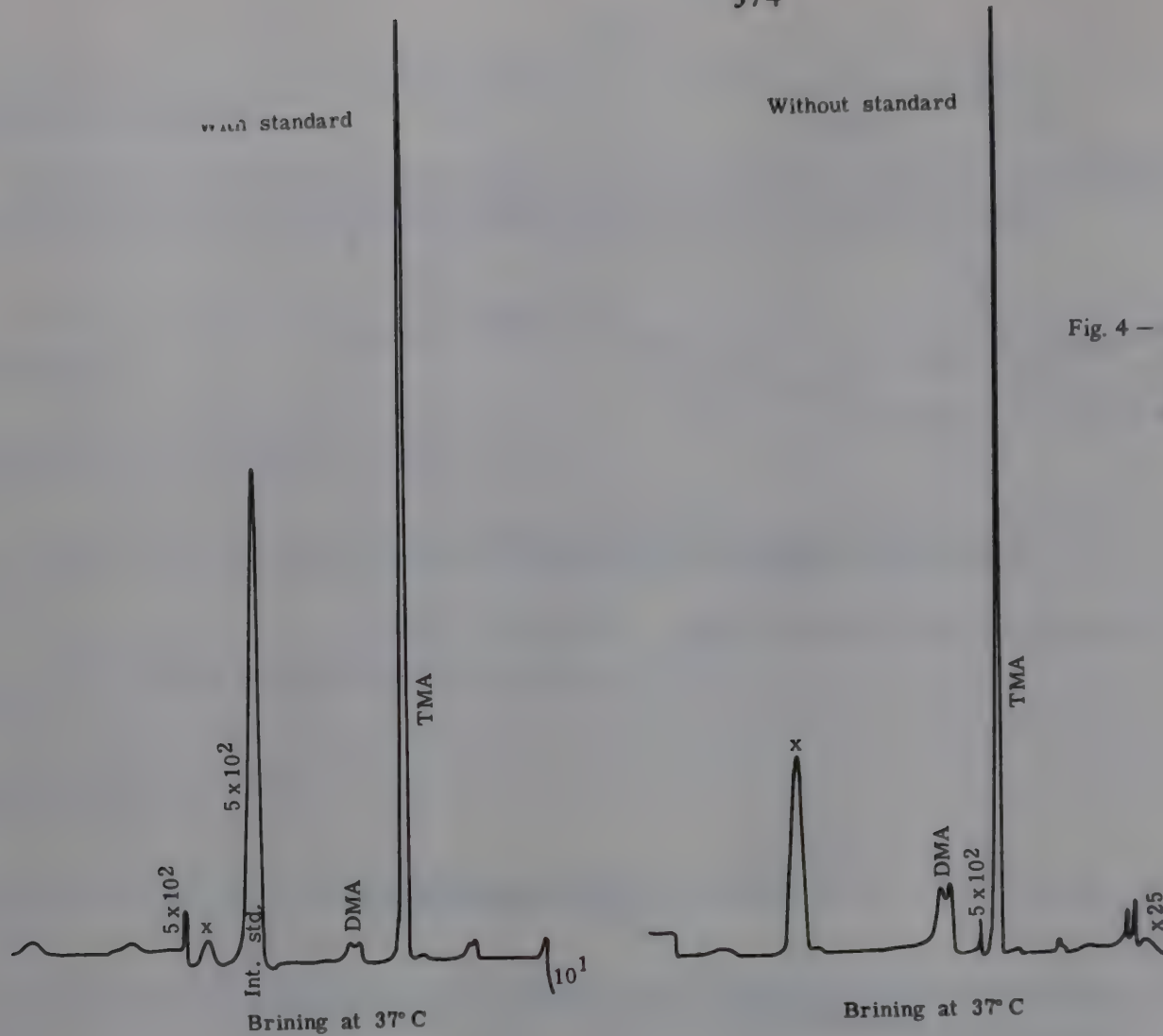


Fig. 4 — Chromatogram of volatile basic components in steam distillate of perchloric acid extract. Herring (*C. harengus*)

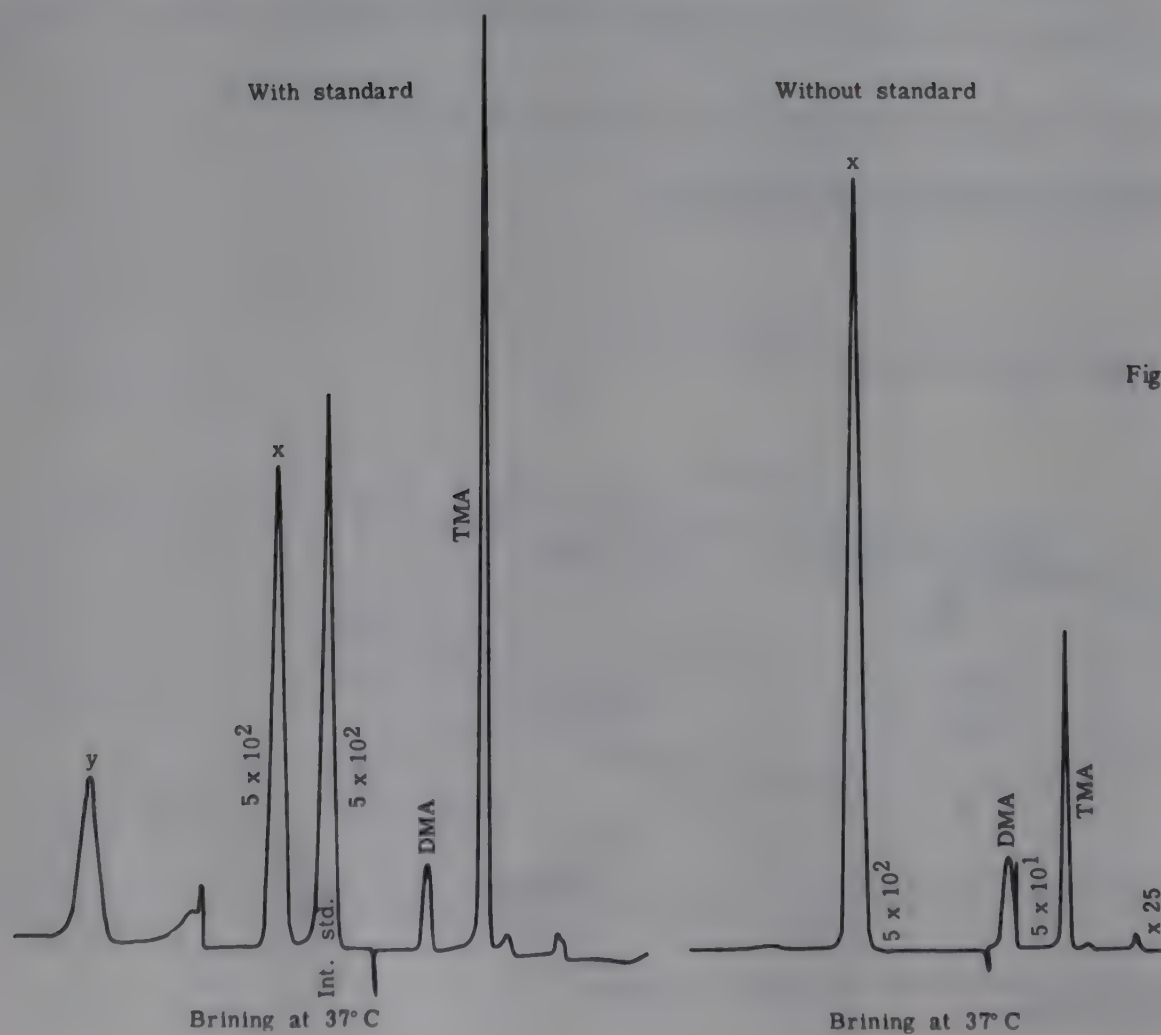


Fig. 5 — Chromatogram of volatile basic components in steam distillate of perchloric acid extract. *S. eba*

AN ATTEMPT TO UTILIZE FISH WASTE AND TRASH FISH IN SRI LANKA

by

T.S.S. Peiris
Research Division, Ministry of Fisheries
Colombo, Sri Lanka

Abstract

Although the amount of fish waste and waste fish available in Sri Lanka is not large, its conversion into useful products is important. Fish meal is produced by the public and private sectors; a portion of the country's requirement is met by imports. Some waste fish which is not utilized could be used for fish silage production in Sri Lanka. Before installing a new fishmeal plant the possible advantages of making fish silage should be investigated. Experimental trials and investigations are needed to assess the best possible means to utilize all fish and fish waste.

INTRODUCTION

Technological research in Sri Lanka began in 1953 with the analysis of the flesh, skin, head, bones, viscera and liver for moisture, ash, fat and protein on several varieties of popular fish (Lantz and Gunsekera, 1957; Peiris and Grero, 1972, 1973). Such analyses form the basis for the optimum utilization of fish in any development programme.

Total fish production in Sri Lanka for the year 1976 was 133 731 tonnes. Since the present production does not meet the demands of the population of 13.7 million, there is a need to use as much of the fish as possible for human consumption. Although the quantity of waste material available is not very high, its conversion into useful products is important.

At present, fish waste and trash fish are not fully utilized although some is converted into fish meal. A fish silage industry has not been established. A portion of discarded fish livers is used for the extraction of liver oil. Skin, heads, liver, bones, fins and skeletal parts offer a further source of material for research and investigation.

FISH MEAL

Fish meal may be defined as the solid product made by removal of most of the water and some or all of the oil from fish or fish waste. It is too valuable to be used as a fertilizer.

The Ceylon Fisheries Corporation is a state-owned organization with two small-scale fishmeal plants; one is situated in Mutwal, Colombo and the other at Pesalai, Mannar. Another small, privately owned plant is also situated at Pesalai, Mannar. At certain fish landing centres waste fish is dried and ground to obtain a product similar to fish meal. A portion of the demand for fish meal is met by imports.

Plants

State-owned plant at Mutwal, Colombo

Operational efficiency of this plant has been impaired by age and it is not running at maximum capacity due to a lack of raw material. Other activities of the Ceylon Fisheries Corporation Complex at Mutwal, include catching, handling, processing and marketing of fish. Thus a major proportion of the raw material for fishmeal production is easily collected within the organization.

Fish waste from the Corporation's marketing is also collected. The process involves cooking, pressing, drying and grinding; there is no recovery of press liquor. Table 1 shows the production data for the plant from 1973 to 1977.

Processing of crude fish meals

At certain fish landing centres in the country, crude fish meals are prepared. One example is the fish landing centre at Kandakkuliya, Kalpitiya where fish offal and inferior varieties of fish are collected, sun-dried and ground to a suitable particle size. This product finds a ready market. Certain poultry food manufacturers also collect waste material at fish curing yards, dry fish store houses, wholesale and retail outlets and grind it to obtain a similar product.

Fish meal and similar products: improvement and development

Occasional checks are made on the quality of the fish meal produced by the state-owned plants. Testing is performed at the Research Division of the Ministry of Fisheries, where samples are analysed for moisture, fat, protein, ash, acid insoluble ash, sulphides and salt. Test results are conveyed to the authorities for necessary action. The quality of the fish meal is satisfactory and its use as an animal feed can be recommended. Few tests are carried out on fish meal produced by the private sector on the crude fish meals.

Investigations on the acceptability and safety of these products are required. These should be oriented toward an improvement in quality. Installation of new fishmeal plants should be considered only after a careful survey has been made. Special attention should be paid to a regular supply, and adequate amounts of raw material for economical running of the process. The private sector plant at Pesalai would provide an ideal model for such a study. It is not advisable at present to install larger plants in any part of the country.

FISH SILAGE

Animal protein can be digested under acidic conditions to produce a stable, liquid product called silage. Fish waste and slaughterhouse waste can be converted into a useful product by this process. Fish silage should be prepared only from fish or fish waste. The product is sometimes known as liquid fish meal.

There are several methods of making fish silage; microbiological fermentation and acid digestion are the most common methods. Enzymes responsible for liquefaction are active at tropical environmental temperatures. The product, like any other liquid, can be transported in bulk in suitable containers. In order to promote easier and cheaper handling, attempts have been made by several workers to produce a dried product from silage. Methods of preparation and potential hazards are discussed by Lantz and Gunsekera (1955) and Disney *et al.* (1977). Investigations into the preparation of fish silage and its subsequent conversion into a dried product are being conducted at the Institute of Fish Technology, Sri Lanka. Disney *et al.* (1977) have reviewed recent developments in fish silage including an account of the work carried out at the Tropical Products Institute, London, to develop a dried silage product for use in the tropics.

Some fish waste (offal) and inferior varieties of fish are discarded at fish landing centres in Sri Lanka. Fish waste is also produced from fish markets and retail outlets, certain types of fishing, for example prawn trawling operations, beach seining operations, etc., and fish processing and curing activities, e.g., processing prawns for preparation of dried and smoked fish, etc. It is impracticable to produce fish meal from this waste but a possible solution is to convert it into fish silage at selected locations. The operation is simple and economical; no sophisticated equipment is required. Flour mill sweepings from the State flour milling corporation could provide a suitable carbohydrate filler for the preparation of a dried product; other fillers could be tried. Fish silage, whether in liquid or dried form, would be a new product in Sri Lanka and great care would be needed in its introduction. Technical and economic feasibility of the operation must also be tested.

FISH LIVER OIL

Fish liver is a source of medicinal oil containing Vitamins A and D. The size of liver, its oil and vitamin content are the important factors for economical extraction of oil from fish livers.

Production

Oil can be removed easily from fish livers by a steam rendering process. Whole livers are cleaned, cut into small pieces and collected in a vat into which steam is passed. After standing, an oil layer is formed at the top. The crude oil is taken off and any free acid present is neutralized by using an alkali (e.g. dilute sodium carbonate solution). The neutralized oil is washed to remove any excess alkali and the resultant oil is treated with a dehydrating agent (e.g., anhydrous sodium sulphate) to remove suspended water. The purified, water-free oil is then stored in the dark until used. For medicinal use this oil should be standardized with respect to its vitamin content; this is done by blending it with a suitable refined edible oil which has a very low acid value (e.g., soy bean oil or ground-nut oil).

Table 1

Fishmeal production: Mutwal Plant

Year	Raw material converted (tonnes)	Fish meal produced (tonnes)
1973	268.86	98.27
1974	373.37	131.84
1975	203.72	72.87
1976	263.05	121.09
1977	116.52	46.56

State owned plant at Pesalai, Mannar

The Ceylon Fisheries Corporation has a small fish canning factory and a fishmeal plant at Pesalai. The purpose of this plant is to convert fish offal, from the canning operation, into fish meal. At present the canning factory is not functioning at full capacity, mainly due to a lack of fish; the fishmeal plant uses waste fish from the prawn catching operations. The raw material is converted into fish meal by a procedure similar to that used in the Mutwal plant. Table 2 shows the production data for the plant from 1973 to 1977.

Table 2

Fishmeal production: Pesalai Plant

Year	Raw material converted (tonnes)	Fish meal produced (tonnes)
1973	120.04	29.07
1974	206.72	48.48
1975	391.49	93.43
1976	325.29	78.76
1977	555.17	121.80

Private-sector plant at Pesalai, Mannar

This plant is smaller than the state-owned one at Pesalai and it also converts a portion of the waste fish from the prawn fishery into fish meal. During glut periods the plant receives too much raw material and at other times it is idle.

The plant is constructed from locally manufactured machinery. Most operations are performed manually, making use of the cheap labour available in the country. Crushed raw material is transferred to the cooker, where it is steam cooked. The cooked material is pressed and the liquor is drained off. The solids are then spread out on a cement floor to dry in the sun. The material is then transferred to a mechanical drier to complete the drying process and finally ground to a suitable particle size. When sun-drying is impossible due to bad weather, the material is dried in a room constructed for the purpose until it is ready for transfer to the mechanical drier.

Although small, this plant makes a significant contribution to the total fishmeal production of the country. An investigation on process control is essential in order to look into possible modifications needed to improve the quality of the final product.

State-owned plant at Mutwal, Colombo

At present, the fish liver oil extraction plant at the Ceylon Fisheries Corporation Fishery Complex in Mutwal, Colombo uses only shark livers. Livers from the Mutwal Fishery Complex and from fish collecting centres, markets and retail outlets accessible to the plant are used. Private fish distributors also send livers by rail in special containers provided by the Corporation. Medicinal and veterinary oils are produced at the plant; medicinal oil is standardized for vitamin A content at 3 000 i.u/g and veterinary oil for vitamin A at 1000 i.u/g. Oil production of the plant from 1973 to 1977 is shown in Table 3

Table 3

Vitamin oil production: Mutwal Plant

Year	Raw material (lb) a/	Medicinal oil produced (gal) b/	Veterinary oil produced (gal) b/
1973	76 355	3 725	996
1974	55 714	2 905	598
1975	38 491	4 129	278
1976	7 712	475	598
1977	19 302	2 529	306

a/ 1 lb = 0.454 kg

b/ 1 gal = 4.546 l

Fish liver oil: improvement and development

Fish liver oil is used for direct human consumption and, therefore, the entire preparation should be carried out under hygienic conditions. Standardization of the final product with respect to vitamin content is very important. Shark liver is economically suitable for oil extraction but experiments are needed to determine the suitability of other fish livers, particularly those from larger fish. At certain fish landing centres, fish livers are discarded or underutilized at present and an effort is needed to transport as much liver as possible to the state owned Mutwal plant. Meanwhile an investigation is required to establish the feasibility of fish liver oil production in other places.

Utilization of fish liver residues

At the Mutwal plant, liver residues, after extraction of the oil, are currently discarded. This residue contains protein, vitamin B₁₂ and other nutritional factors and its utilization would be important. A method of converting this material to a stable hydrolysate has been devised by Gunsekera (1958).

CONCLUSION

Conversion of fish waste and waste fish into useful products is important. Possibilities for the improvement and development of fish meal and fish liver oil industries are mentioned in this paper. The possible introduction of fish silage production is also outlined but experimental trials and testing are essential.

REFERENCES

- Disney, J.G., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In* Proceedings of the Conference on 1977 the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 231-41
- Gunsekera, C., Utilization of fish liver residues. *Proc.IPFC*, 8(2):89-92
1958
- Lantz, A.W. and C. Gunsekara, Liquid fish "meal": biological and technological. Fisheries Research Station, 1955 Colombo, Sri Lanka. *Prog.Rep.Fish.Res.Stn., Colombo*, (1):7-10
- _____, Chemical analysis of some Ceylon fishes. *Bull.Fish.Res.Stn.Ceylon.*, (5):34 p.
1957
- Peiris, T.S.S. and J. Greco, Chemical and analyses of some Ceylon fishes. 2. *Bull.Fish.Res.Stn., Sri Lanka*, 23
1972 (1-2):1-7
- _____, Chemical analyses of some Sri Lanka fishes. 3. *Bull.Fish.Res.Stn., Sri Lanka*, 24(1-2): 1-12
1973

A NOTE ON THE DEVELOPMENT OF NEW DRIED FISH PRODUCTS

by

Fish Processing Division
 Fisheries Research and Development Agency
 Office of Fisheries, Republic of Korea

Abstract

Traditional dried products are generally made from small fish. Nontraditional large fish are more difficult to dry in a standardized manner. Procedures are described for the development of novel dried products using fish mince.

INTRODUCTION

Fish used for traditional dried fish products have been relatively small in size, e.g., squid (*Sepia esculenda* hoyre), file fish (*Stephanolepis cirrhifera*), globe fish (*Sphaeroides rubripes*), half beak (*Hemiramphus sajori*), etc. Since these fishes are flat they can be treated and dried easily. On the other hand, large round fish such as Alaska pollack (*Theragra chalcogramma*), cod (*Gadus macrocephalus*), etc. are not easily dried and there is also a difference in the drying time between the body and the tail; this makes it difficult to produce a standardized product.

Traditional dried fish processing was unsanitary and inefficient because it was based mainly on manual operations. This experiment was conducted to overcome such shortcomings and to improve the products. The fish were frozen in containers before being sliced and dried. It was found that a standardized product with an enhanced rate of drying could be produced. Two products were made; one from fish fillets and the other from cheap and less valuable fish, and from minced trimmings from the filleting operation.

PROCESS

For the preparation of fillets a filleting machine was used. The mince was obtained from species of low value and from filleting waste by means of a meat/bone separator.

Essentially the process for both products consisted:

- bleaching the fish in water; for minced products, 3 parts water to 1 part fish;
- dehydrating in a centrifuge;
- seasoning with additives such as salt, sugar, D-sorbitol, glucose, sodium glutamate, sodium succinate, polyphosphate, etc.;
- freezing in trays (48.7 x 29.5 x 6 cm) in a contact plate freezer to a centre temperature of -4° to -5°C ;
- slicing with an electric band saw, and meat slicer to give thin slices;
- drying; Alaskan pollack was sun-dried for 4-7 hours during the period September to November and for 5-9 hours from May to September, and
- finally, the product made from the mince was roasted in a machine at 180°C and softened by passing 2 or 3 times through a roller.

If the raw material was of poor quality, the product made from fillets tended to crack during drying and the product made from mince was not easily softened even if rolled. When the major part of the raw material was Alaska pollack, a product with good texture and colour could be obtained by mixing 3-4 percent of squid, file fish, globe fish, shrimp, crab, laver, etc.

ADVANTAGES OF THE PRODUCTS

Possibility of mass production.

Speed of drying

Since the minced type product can be produced using various species of fish, a variety of products can be produced

By-products produced in fish processing can be utilized

The fillet type product is of good shape and can be torn easily

FISH NOODLES

by

R. Pruthiarenun and J. Setabrahamana
Fishery Technology Development Division
Department of Fisheries, Bangkok, Thailand

Abstract

The paper describes fish noodle production and consumption in Thailand. It describes the steps which have been taken to develop a product containing wheat flour and fish at acceptable levels, and to prolong the storage life by dehydration and suitable packaging. The moisture content (6-7 percent) and light yellow colour of the product were acceptable. Scales of production and the relation to ground or minced fish utilization, including the prospects for their introduction, are also considered.

INTRODUCTION

Noodles are common in the Thai diet and they are produced in many small factories for distribution to small restaurants. Noodles are also popular in household cooking. A considerable quantity of noodles are consumed daily by the Thai people and one possible way to increase protein consumption is to add ground or minced fish to the noodle mixture. Dehydration will prolong the storage life of the products and facilitate distribution to distant consuming areas. If this concept is accomplished and integrated into the National Nutrition Development Program, it will minimize, to some extent, the degree of malnutrition which is found in different areas of Thailand.

MATERIALS AND METHOD

The main components of fish noodles are wheat flour and ground or minced threadfin bream fish. This fish is representative of the inexpensive varieties which are available. The other ingredients are 1 percent sodium carbonate, 1 percent sodium chloride, 0.5 percent sodium glutamate and 0.0-0.5 percent potassium pyrophosphate (based on the dry-basis of the main mixture). For the control sample (noodles without fish), 370 cm³ water is added to 1 kg of flour.

The proportion of fish to flour used is 3:5. This proportion was calculated to attain 34-40 percent moisture content which gives the required elasticity for mixing, rolling and cutting.

PROCESSING METHOD

Steps used for the noodle processing were as follows:

- (1) **Mixing:** the fish are stirred in a mortar with an electric stirrer. Then the other weighed ingredients and the flour are added gradually and mixed.
- (2) **Rolling:** the mixture is passed between two rollers to produce a thin sheet of the product. These thin sheets are faced together and passed through the rolling machine again; this step is repeated until a thickness of 1.5 mm is obtained.
- (3) **Cutting:** the thin sheets are passed through cutting rollers to produce fine noodle strips; the width of each strip is about 1.5-2.0 mm.
- (4) **Weighing and folding:** the fish noodle strips are folded to give a rectangular fold of 3 x 3 inches and a weight of 40 g.

(5) Steaming: in order to increase the elasticity and smoothness of the product the fish noodles are steamed for 5 minutes.

(6) Drying and cooling: the noodles are laid on a screen and dried at 70°C for 3 hours, with the appropriate rate of air flow, in a Torry kiln. After drying, the heater is turned off and the product is cooled by the air flow inside the kiln.

(7) Packaging: the products are packed in polyethylene bags and kept at an average room temperature of 36°C and average relative humidity of 75 percent.

EXPERIMENTAL VARIATIONS

(1) Examining the elasticity of the noodles, produced after various mixing times, and comparing the results obtained with the plain wheat flour noodle (control).

(2) Examining the elasticity of the noodles using variable amounts of potassium pyrophosphate ranging from 0-0.5 percent by using the mixing time (determined in 1).

(3) Cooking the fish noodles according to local recipes and carrying out acceptability tests.

Composition of raw materials and products

Protein and moisture contents by the raw material and products are given in Table 1.

Table 1

Protein and moisture contents of raw materials and products

Sample	Protein content ^{a/} (%)	Moisture content (%)
<i>Raw material</i>		
Minced fish ^{b/}	15.12	76.00
Ground fish	19.70	76.00
Wheat flour	10.30	3.60
<i>Fresh product</i>		
Minced fish noodle	12.5	38.86
Ground fish noodle	15.8	38.00
Plain wheat flour noodle	10.3	34.04
<i>Dried product</i>		
Minced fish noodle	12.5	6.87
Ground fish noodle	15.8	6.87
Plain wheat flour noodle	10.3	6.50

a/ On dry weight basis

b/ Washed ground fish

Although wheat flour has a high protein content, many reports have shown that the protein quality in fish is superior to that in wheat flour and has a much higher biological value. Fish protein contains essential amino acids, especially lysine, and methionine, which are lacking in cereal foods.

Elasticity evaluation

Elasticity is the main quality factor of noodles, experiments were therefore conducted to find out the best conditions for developing the elasticity required.

The noodles used for elasticity evaluation (from Experiments 1 and 2) were removed from the packages and rehydrated in 100°C water for 5 minutes. Then water was drained out and each fish noodle roll was served to a panelist. Each panel consisted of 8 members alternately selected from a group of 30 individuals of the laboratory. Panellists were asked to award a score for elasticity according to the ratings in Table 2. The results of the first experiment are shown in Table 3. It is evident that the proper mixing time is at least 5 min; there seems to be no significant difference in elasticity between the products nor between the longer mixing times. In addition, the scores have shown that the elasticity of the products is higher than the 'moderate/good'.

Table 2

Taste panel ratings for elasticity

9 — extremely good elasticity	4 — slightly bad elasticity
8 — very good elasticity	3 — moderately bad elasticity
7 — moderately good elasticity	2 — very bad elasticity
6 — slightly good elasticity	1 — extremely bad elasticity
5 — neither good nor bad elasticity	

Table 3

Elasticity evaluation of noodles after various mixing times

Mixing time (minutes)	Average score for elasticity		Ground fish wheat flour noodle
	Wheat flour noodle (without fish)	Minced fish wheat flour noodle	
3	6.2	5.5	5.2
5	7.5	7.8	7.3
10	7.6	7.7	7.5
15	7.6	7.8	7.7

The elasticity scores for Experiment 2 are shown in Table 4. The highest elasticity can be developed by adding 0.3 percent potassium pyrophosphate and the elasticity scores do not vary significantly between 0.3 and 0.5 percent potassium pyrophosphate.

Table 4

Elasticity evaluation of noodles with different potassium pyrophosphate

Percentage of potassium pyrophosphate	Average score for elasticity		
	Wheat flour noodle	Minced fish noodle	Groundfish noodle
0.0	7.6	7.7	7.7
0.1	7.5	7.6	7.7
0.3	8.1	8.2	8.0
0.5	8.1	8.0	7.9

Acceptability of fish noodle soup

The best noodles from Experiment 2, both minced and ground fish, were removed from the bags and rehydrated in 100°C water for 5 min and were then put in dish together with other ingredients. The procedure and recipe are the same as those used in restaurants. The dishes were served to the same panel group as before. Panelists were asked to rate acceptability of four attributes: flavour, colour, texture and odour with a 6-point difference scale. Written instructions for acceptability were given; no specific training was provided but the panelists were already experienced with local wheat flour consumption. Samples were served one at a time.

Mean acceptance panel ratings are shown in Table 5. There was no significant difference between the samples. This result may arise because the ingredients have a greater collective effect than the fish noodles by themselves.

The flavour of this product is not unpleasant, the odour is pleasant and the colour is pale yellow.

Table 5

Sensory evaluation score for fish noodle soups

Type of sample	Mean difference test score ^{a/}			
	Flavour	Colour	Texture	Odour
Wheat flour noodle	5.0	4.2	4.7	4.3
Minced fish noodle	5.1	4.3	4.7	4.5
Ground fish noodle	5.1	4.1	4.5	4.4

a/ 6-point difference test scale: 6 – excellent
1 – very poor

Shelf-life study

The results of a storage trial of the fish noodles are presented in Table 6. The product was found to have a shelf-life of one month.

Table 6

Shelf-life of fish noodles

Storage time ^{a/} (days)	Wheat flour noodle (control)	Minced fish noodle	Ground fish noodle
0	Light yellow	Light yellow	Light yellow
55	Very light brown	Light brown	Very light brown/yellow
165	Slightly brown/yellow	Brown	Brown
225	Yellow/brown	Brown	Brown

a/ At ambient conditions, 30°C and 75% percent relative humidity

Marketing trials

The dried minced fish noodle folds were packed in polyethylene bags together with a questionnaire. The price of each bag containing 5 folds of the product is 5 bahts (U.S.\$ 0.25). A number of packs were on display, together with other fishery products, at a Red Cross Fair; some 200 bags of product were sold and two months later 45 questionnaires were returned. The questionnaire contained instructions for rehydrating the product and the rough sensory evaluation of three attributes: i.e., elasticity, flavour and odour. In each case three levels of acceptance were possible, good, moderate and poor. The evaluation of the 45 questionnaires indicated that the elasticity is moderate and that the flavour and odour are acceptable.

Other considerations

For production in the home a simple machine is readily available in Thailand. The machine comprises one roller, one cutter and a motor, cost 1 200 bahts (U.S.\$ 60) and has a capacity to produce 600 folds of fish noodle per day. The daily cost of production, without a drying operation, is about 350 bahts (U.S.\$ 17.5). The selling price is about 540 bahts (U.S.\$ 60) per day, therefore, the profit will be about 90 bahts (U.S.\$ 4.5) per day.

For a small factory the cost of the machine required would range from 8 000 to 20 000 bahts (U.S.\$ 400-1 000). By using a machine of this capacity, the rate of noodle production will increase to at least 6 000 folds per day. A drying operation may be needed if the fresh product cannot be distributed to the consumers in one day; in this case, more capital is required. However, the owner can make more profit and recover the invested capital over a period of time.

Other types of noodle

Besides the wheat flour noodle, rice noodles are also important in Thai dishes. The same concept and practice can be applied to these products and the cost of production will be much cheaper as the rice is produced locally. Rice noodles need different processing techniques and some experimentation would be needed to develop fish-rice noodles.

Ground or minced fish utilization

If the techniques and equipment for separating fish flesh from bones are developed, it will be possible to use greater amounts of both marine and culture freshwater fish. The ground or minced fish factories will then probably develop a higher production capacity to supply material for fish noodle production.

CONCLUSION

The amount of fish added to this type of noodle is limited by the moisture content of the minced or ground fish. This is because 34-40 percent moisture is required in the final mixture so that it can be rolled properly into noodles. The best elasticity of the noodle is developed after 5 min mixing and 0.3 percent potassium pyrophosphate content. The shelf-life of the dried product is being further investigated by the authors.

To promote the acceptance of this type of product and thereby increase the consumption of protein, the extension services should carry out extensive field trials.

SALTED MINCED FISH TRIALS

by

L.W. Regier, M.B. Wojtowicz, M. Fierheller and S. Varga
Technology Branch, Fisheries Management
Department of Fisheries and Environment
Halifax, Nova Scotia, Canada

Abstract

The advent of meat/bone separators for providing a high yield of minced flesh from many species presents new opportunities for fish utilization. Salting of the minced flesh provides a rapid and inexpensive method of preservation.

Salted mince has been shown to require drying or the addition of an inhibitor, such as sorbic acid, to prevent microbial spoilage during long-term storage at ambient temperatures. Initial trials of a dried, shredded form in 10 countries have met with mixed responses. Generally, good acceptance was indicated in those locations where the people are accustomed to eating salt fish.

INTRODUCTION

The recent application of meat/bone separators to fish has presented new opportunities. The bones, which are one of the major objectionable factors in fish for many people, can be removed effectively from fish flesh. Also, greater yields of edible flesh can be obtained. In cases where the fish are traditionally hand filleted and only the fillet is used for food, as much as 100 percent more flesh can be recovered. The major uses of machine-separated flesh have been in the washed and frozen, or washed and cooked, forms as represented by the surimi and kamaboko of Japan. Since the mincing operation spreads any spoilage organisms which are present throughout the flesh, there has not, as yet, been a very large direct use of wet (or fresh) mince parallel to the use of ground beef. There appears to be a need for methods of preserving minced flesh which are not dependent upon refrigeration in the distribution system. Salting preservation presents our solution to this need.

TRADITIONAL SALTING

When whole or split fish are salted by traditional methods, a period of several days to several weeks is needed for the salt, in contact with the surface, to dissolve and diffuse into the flesh to fully salt out the proteins. At the same time, there is a diffusion of water out of the flesh forming free brine on the surface. At this point of full salting, the product is stable for a short time but must be kept cool or it will spoil microbiologically. For further stabilization, the salt fish is normally dried. During drying, the rate of diffusion of water out of the flesh is normally the limiting factor; the maximum drying temperature must be kept low or the fish will cook. Also, rapid drying can lead to "case hardening" in which a crust forms and greatly decreases the rate of drying.

SALTING OF MINCED FISH

There are several approaches which may be taken in salting minced fish.

- (a) *Salting the mince in block form.* The minced flesh is formed into a block which is then handled in the traditional way. However, this allows the spoilage organisms in the centre of the block to grow before it is salted.
- (b) *Partial salting and drying.* The mince is mixed with some salt that will be effective in inhibiting some of the spoilage organisms, and is then dried. Since the proteins are only partially salted they form a gel; the product is very difficult to dry and, subsequently, to desalt for cooking.

- (c) *Full salting of mince.* Sufficient fine salt is mixed with the mince to fully saturate the water which is present in the flesh. Free brine is formed which can be removed efficiently by pressing or centrifugation.

This product is still susceptible to slow spoilage by halophilic bacteria or moulds since it has the water activity of a saturated salt solution, equivalent to 75 percent relative humidity.

Microbial stability of salted minced fish

Fully salted (equivalent of saturated salt solution) minced fish can be kept free from apparent spoilage by halophilic bacteria by storage below 5°C. This is essentially what is done with traditional salt fish in the cool climates.

Two methods to prevent this spoilage were investigated in our laboratories: drying and the addition of sorbic acid (an approved food additive in many countries).

When salted minced fish was inoculated with cultures of halophilic bacteria, it was shown that a product dried to a water content equivalent to 70 percent relative humidity was the limit for growth of the spoilage organism. In our salted minced fish this was at about 24 percent moisture. Thus a product with a moisture level below this was found to have a shelf-life at ambient or higher temperatures (up to 35°C) for many months.

Later studies, with sorbic acid added to the salt, showed that a level of 0.3 percent sorbic acid (calculated on the wet mince basis) was effective in preventing spoilage even when the mixture was inoculated with halophilic bacteria. Using this approach, a non-dried product containing 0.36 percent sorbic acid was shown to be stable for several months at 35°C. The product had 40-45 percent water, 24-26 percent salt and 30-35 percent fish solids (mostly protein). When desalted with 10 times its weight of water, the final ready-to-eat material had about 0.1 percent sorbic acid.

Pilot trials

A decision was made to proceed with pilot plant production and feeding trials before the results of the sorbic acid studies were available. The product was thus made using the drying method for preservation. A total of 6 tonnes of dried, salted minced fish were prepared in the pilot plant of the Technology Branch Laboratory from split cod fish. This traditional raw material was chosen as a regular supply of 50 kg lots was required for pilot plant batches. The dried, salted mince contained about 20 percent water, 40 percent salt and 40 percent fish solids (mainly protein). It was packaged in laminated foil-polyethylene bags in 0.5 kg quantities.

With the kind cooperation of the Fisheries Prices Support Board of Canada and the World Food Programme, this material was shipped to 10 countries for testing.

Acceptability

Schools and hospitals were used primarily for preparing and serving this trial product to consumers. The Fisheries Food Centre in Ottawa had prepared a variety of recipes, for using the salted minced fish, which were included with the brochure and questionnaire that was shipped along with the product to ten locations.

Of the eight reports received, four indicated an enthusiastic to a very favourable response to the product and two indicated that the product was acceptable but there were some reservations about its use; two of the locations found the product unacceptable. The final two locations have not, as yet, been able to carry out the trials.

The six acceptable responses are quite encouraging. However, a close inspection of the questionnaires indicated that the major objections to the salted minced fish came from places where the participants are not normal users of salt fish. Part of the problem may be the characteristic flavour of salt fish which is at first objectionable to those not familiar with the product. In some of the trials the product was over a year old when tasted.

These trials have shown that it is possible to produce salted minced fish by a rapid process. The product is stable, when protected by packaging, for a long period and is fairly well accepted by consumers throughout the world.

STUDIES ON TRADITIONAL METHODS OF FISH SMOKING IN THE PHILIPPINES

by

M.A. Anenias, A.M. Mabeza, T.R. Miciano and E.C. Sison
Department of Food Science & Technology, College of Agriculture
University of the Philippines at Los Baños
Laguna, Philippines

Abstract

Traditionally smoked fish is very unstable and cannot be kept for more than a week without refrigeration. This study was conducted to explore ways of prolonging the shelf-life of smoked fish at room temperature.

Surveys were conducted on the methods of smoking fish in three areas of the Philippines. Samples were taken for chemical, i.e., nitrogen (TVN), thiobarbituric acid (TBA) and trimethylamine (TMA), and microbiological analyses to measure the rate of spoilage. Also, the smoking methods were simulated in the laboratory on five species to evaluate the general acceptability of the products.

The survey showed that methods of fish smoking are varied; this may be attributed to species differences, marketability and consumer preferences but, based on sensory evaluation, the different methods resulted in equally acceptable products.

The products deteriorated at varying rates depending on the moisture and salt content; those with high moisture and low salt content deteriorated more quickly. The TVN, TBA, and TMA values increased slightly during storage. Microbial counts increased with the storage; *Bacillus* and *Micrococcus* spp. predominated.

As a result of these studies new procedures are proposed. For small species and fatty fish, simultaneous cooking and hot smoking is recommended. Fatty fish should be split to enhance fat loss and dried before smoking in order to reduce moisture. Moreover, antioxidants and mould inhibitors may be used to prolong shelf-life.

INTRODUCTION

Fish and fish products are a major source of protein in the Filipino diet. Most fish are consumed in the fresh form but some undergo processing particularly salting, drying and smoking. Traditional smoked fish is particularly popular in Luzon.

Previous studies and surveys on the processing of fish show that different methods of fish smoking are practised in different areas of the country (Guerrero and Medina, 1976), depending on the species, marketability, economic considerations and general consumer acceptability.

Large-scale processors are few; most smoked fish comes from small cottage level processors who produce only one day's supply because the products are unstable without refrigeration and they cannot afford refrigeration facilities. Smoked fish is acceptable for only two or three days.

This study was conducted in an attempt to prolong the shelf-life of smoked fish without refrigeration through improvements of the processing procedures.

MATERIALS AND METHODS

Fish smoking was surveyed in three areas of the Philippines namely: Mercedes, Camarines Norte; Rosario, Cavite; and Navotas, Metro Manila. The flow charts of typical processes in each locality are given in Figs. 1, 2 and 3.

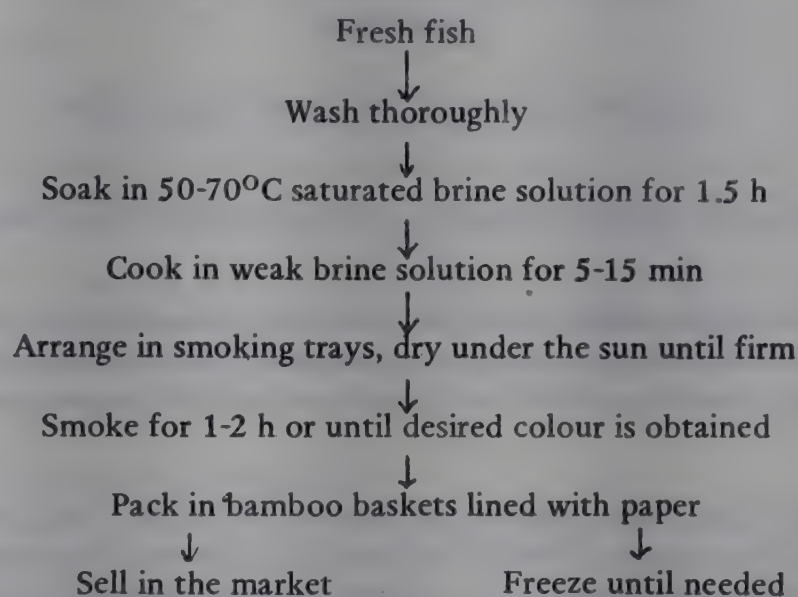


Figure 1. Method of smoking in Mercedes, Camarines Norte

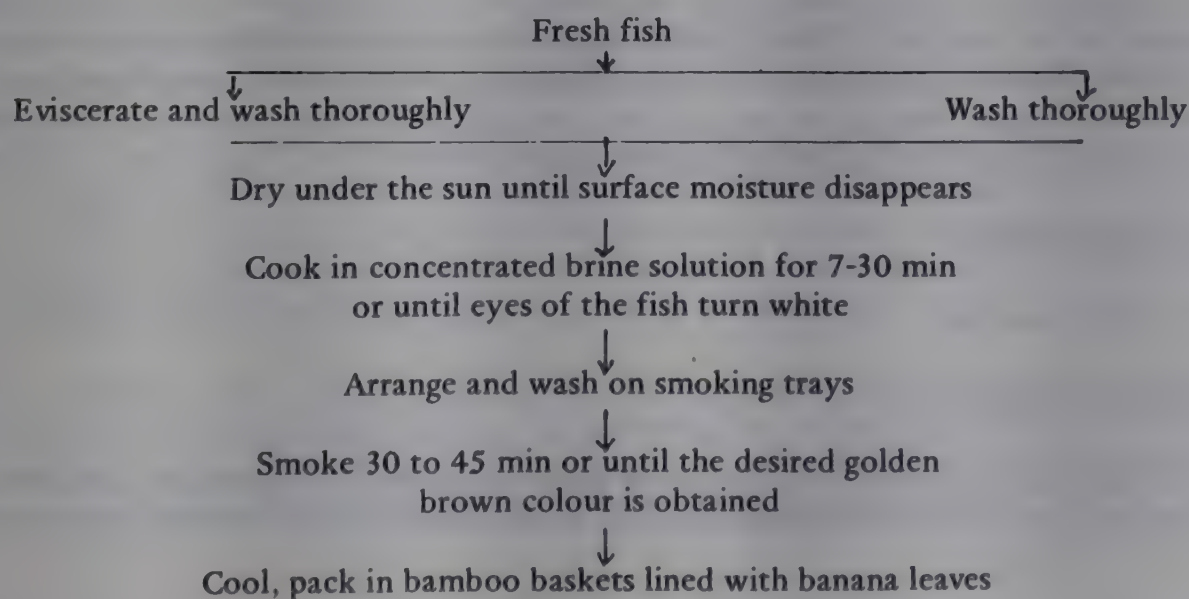


Figure 2. Method of smoking in Rosario, Cavite

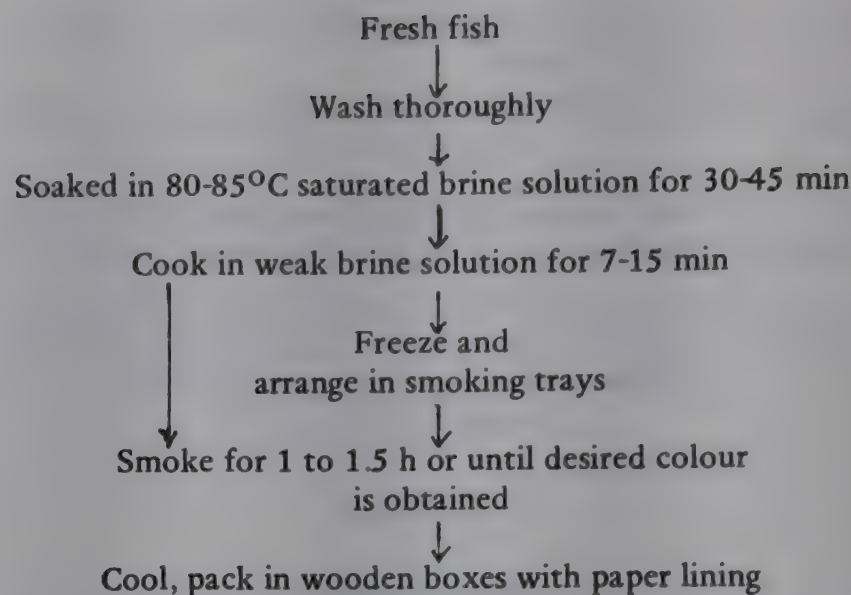


Figure 3. Method of smoking used in Navotas, Metro Manila

Smoked roundscad (*Decapterus macrosoma*), known locally as galonggong, were collected from different smokehouses. Samples were taken during processing to determine chemical and microbial changes. The samples were placed in clean, dry bottles and kept in ice during transport to the Department of Food Science and Technology.

The fish samples were filleted and comminuted prior to testing for: moisture and salt content (standard AOAC procedure), total volatile nitrogen (TVN) (Lucke and Geidel's macrodistillation method), trimethylamine (TMA) (Conway's micro-diffusion method), and thiobarbituric acid (TBA) values using the perchloric extraction of malonaldehyde.

Total plate counts were made during processing and storage and isolates were taken for further identification.

Consumer acceptability of the smoked fish was evaluated by a taste panel composed of departmental staff using the scorecard in the Appendix. Since it was desirable for all smoked fish samples to be presented at the same time, the different methods of smoking were simulated in the laboratory using 5 species of fish. The products were subjected to sensory evaluation one day after smoking. The mean panel scores for overall acceptability were analysed statistically using the analysis of variance technique.

RESULTS AND DISCUSSION

Typical methods of fish smoking

Sorting and cleaning of fresh fish

In Mercedes and Navotas, only small species of fish, ranging from 10 to 20 cm, are used for smoking; In Rosario, both large and small species of fish are smoked; the larger species are eviscerated prior to processing.

Drying

In the Cavite area, fresh fish are arranged on bamboo trays and partially sun-dried to help firm up the fish during brine cooking. In Mercedes, however, the surface drying of fish was carried out after brine cooking; partial drying is not practised in the smoking method used at Navotas.

Brining

In Mercedes and Navotas the fish are soaked in a saturated brine solution prior to weak-brine cooking. In Cavite, the fish are cooked directly in saturated brine. Absorption of salt takes place during cooking and the fish are washed to remove excess salt prior to smoking.

Smoking

Hot smoking is the common practice in all areas. The smoking ovens usually have an internal temperature of 70 to 100°C. In Mercedes and Navotas, the fish are smoked for 1 to 2 hours or until the desired golden brown colour is obtained. In Cavite, the fish are smoked for only 30 to 45 minutes but this is enough to impart a smoked flavour and brownish appearance.

Packing and storing of smoked fish

In all areas, smoked fish products are arranged in bamboo baskets lined with paper or banana leaves. Smoked products from Mercedes have the most salty and smoky flavour and are more glossy than those from Navotas; both products are dry and tough. The Cavite product is shiny, moist and juicy.

During the peak season in Mercedes, the fish are processed in bulk, placed in cold storage, taken out and sold in the market. In Navotas, the fish are cooked in bulk in rattan baskets, placed in cold storage and smoked only when the supply of fresh fish is scarce. The Cavite processors, however, cannot take advantage of abundant supplies due to the lack of cold storage facilities.

Chemical and microbiological evaluation of roundscad

During processing

The results of chemical and microbiological analyses of roundscad during processing are summarized in Table 1. In all cases the moisture content of fish flesh decreased and the salt content increased as processing proceeded. The smoked fish products from Mercedes and Navotas contained 12 to 13 percent water-phase salt content while those of Cavite had 4.5 percent only. A high waterphase salt content is desirable to retard bacterial spoilage.

There was no specific trend in the TVN values. The fish were still acceptable at TVN values of 30 mg N/100 g of sample. The smoked samples from Cavite had relatively high TVN values and high microbial counts.

The microbial count, in general, decreased as processing continued. Fresh fish from Mercedes had a log count/g of 5.34 but this decreased to 2.47 in the smoked product. The fish from Cavite had a log count/g of 5.52 which dropped to 5.03 after cooking, then increased abruptly after smoking. These high counts could be attributed to the poor quality of the raw materials used or to improper handling and poor sanitation during processing. Most of the bacteria isolated were Gram-positive cocci and *Bacillus* spp.

Brining has a selective action on the fish flora; suppressing, to some extent, the *Pseudomonas* spp., which are considered to be most active spoilage bacteria, but allowing the coryneforms and *Micrococcus* spp. to predominate. Zaki *et al.* (1976) found that total plate counts on Nile boliti (*Tilapia nilotica*) decreased and that coliforms (which were present in the fresh fish) were absent with increased brining time.

During storage

The smoked samples were monitored daily for chemical and microbiological changes and the results are given in Table 2. The smoking procedures affect the stability of the product as shown in the TVN, TMA, TBA and microbial counts during storage. The smoked fish from Cavite were edible only for three days; on the fourth

day they were already slimy, mouldy and putrid. The TVN, TMA, TBA and microbial counts of the products at this stage were relatively high compared to those from Navotas and Mercedes.

The smoked fish from Navotas became mouldy after 5 days and were discarded. The TBA values were high; this may be due to fat oxidation which occurred during frozen storage (for several weeks) of the cooked fish before smoking. Yu and Sinnhuber (1968) reported that canned and frozen fish of good quality had TBA values of less than 3 while products of poorer quality had TBA values from 4 to 27. Although the smoked fish had TBA values as high as 28, the rancid taste in the fish was not strong. These high TBA values may indicate that the raw material was of poor quality.

The samples from Mercedes were spoiled after seven days because of thick mould growth. The TMA, TVN and TBA values increased only slightly during storage. Seasonal variation of the trimethylamine oxide contents and variability in the proportion of organisms able to reduce trimethylamine oxide affect the production of TMA (Woolen, 1970).

The predominant bacteria in smoked samples from Navotas were *Micrococcus* spp. while those from Cavite were *Bacillus* spp. Hot smoked fish may reach a temperature of 65-75°C for 20 minutes or more and the more resistant mesophiles and spore formers will still survive.

Table 1

Chemical and microbiological analyses of roundskad during processing

Area	Stage of processing	Moisture (%)	Salt (%)	Water-phase salt (%)	TVN (mg N/100 g)	Log count (per g)
Mercedes	Fresh	73.35	0.75	1.01	30.49	5.34
	After brine-soaking	68.75	2.90	4.05	29.75	5.85
	After drying	NA	NA	NA	NA	NA
	After brine-cooking	5.20	4.05	6.50	31.94	3.93
	After drying	55.40	5.75	9.40	32.20	3.42
	After smoking	48.10	7.03	12.75	33.60	2.47
Cavite	Fresh	73.11	0.58	0.78	33.41	5.52
	After brine-soaking	NA	NA	NA	NA	NA
	After drying	68.43	1.02	1.47	36.45	5.03
	After brine-cooking	68.37	2.05	2.91	30.38	2.90
	After drying	NA	NA	NA	NA	NA
	After smoking	65.25	3.08	4.50	42.53	6.52
Navotas	Fresh	72.30	0.78	1.07	26.70	—
	After brine-soaking	65.70	2.50	3.67	22.30	—
	After drying	NA	NA	NA	NA	NA
	After brine-cooking	51.50	5.61	9.82	18.87	6.55
	After drying	NA	NA	NA	NA	NA
	After smoking	49.50	6.85	12.15	18.15	2.47

NA = applicable

Table 2

Chemical and microbiological analyses of smoked roundscad during storage

Area	Days' storage	TVN (mg N/ 100 g)	TMA (mg N/ 100 g)	TBA (mg malon- aldehyde/kg) kg)	Log count (per g)
Mercedes	1	33.60	8.70	15.55	—
	2	35.40	7.50	15.55	—
	3	29.70	9.26	18.14	6.97
	4	30.10	10.08	15.55	—
	5	27.81	8.50	23.04	—
	6	31.80	10.82	26.40	—
	7	36.37	15.96	30.03	—
Cavite	1	42.53	17.20	10.00	6.52
	2	45.57	19.18	14.00	7.60
	3	54.68	20.28	15.70	8.40
Navotas	1	18.15	19.49	26.41	2.47
	2	21.78	16.04	21.89	6.22
	3	23.23	20.72	24.74	7.36
	4	31.87	20.30	25.70	7.85
	5	48.03	22.48	28.67	8.32

Acceptability of smoked products

The processors claim that the method of smoking is dictated by the consumers' preference. Cavite processors supply smoked fish to some parts of Manila, Rizal, Batangas and Laguna where people prefer tender, juicy but not salty smoked fish. People on the northern part of Luzon and some parts of Manila are said to like tender, juicy and salty smoked fish. This group is supplied by Navotas processors. Mercedes supplies the whole of the Bicol region, where the preference is for salty and slightly tough, smoked fish.

Differences in consumer preference were tested by conducting a sensory evaluation on a 9-point hedonic scale; 15 panellists from different regions of the country took part. The species tested were freshwater milkfish, brackish-water milkfish, Indian sardines, roundscad and fimbriated herring. The mean scores of the 15 panellists are give in Table 3.

Table 3

Acceptability of different species of fish processed by 3 methods of smoking

Species	Mercedes	Cavite	Navotas	Mean ^{1/}
Roundscad	6.71	6.85	6.69	6.75 ^a
Fimbriated herring	5.43	6.71	6.57	6.24 ^{ab}
Freshwater milkfish	6.12	6.43	6.29	6.28 ^{ab}
Indian sardines	6.00	5.76	6.15	5.97 ^b
Brackish-water milkfish	5.68	5.43	5.86	5.62 ^c

1/ There is a significant difference (at 5% level) between means with different superscripts

Analysis of variance showed that acceptability is affected by the species of fish (at 5 percent level of probability). Different individuals have species preferences for smoked fish but the methods tested all produced smoked fish that are equally acceptable.

RECOMMENDATIONS

Alternative methods of smoking

As a result of these studies, the authors propose improvements in smoking procedures shown in Figs. 4, 5 and 6. These improvements could help to minimize handling, improve sanitation and take into account species, size and fat content of the fish. The proposals are still theoretical, however, and further experimentation is required.

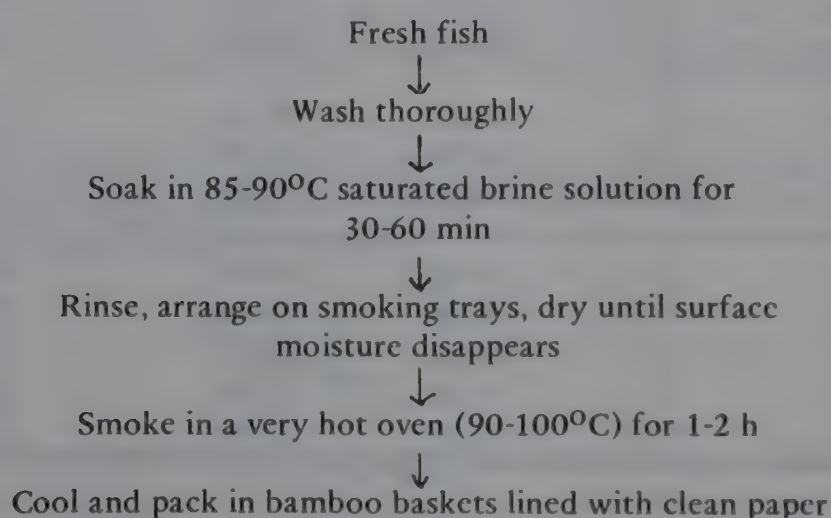


Figure 4. Suggested method for smoking fish 20 cm or less in length

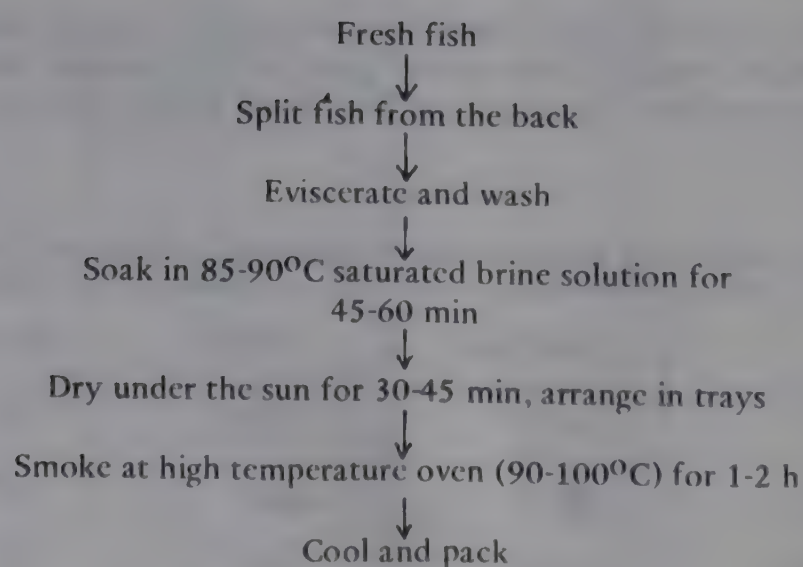


Figure 5. Suggested method for smoking fatty fish more than 20 cm in length

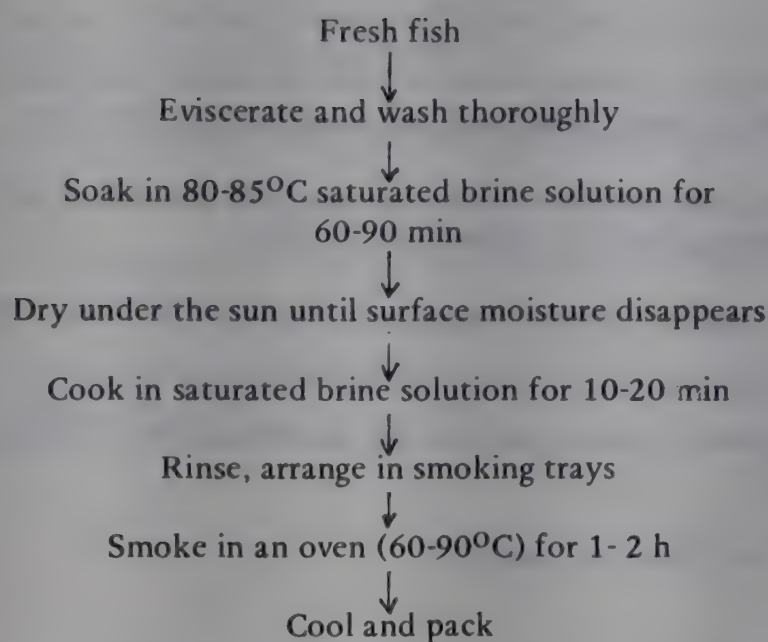


Figure 6. Suggested method of smoking of lean fish more than 20 cm in length

The recommended process for small species (Fig. 4) produces a product, with 8 to 10 percent salt and 50 to 55 percent moisture, which will be stable for 6 to 8 days at room temperature.

For larger species of fish which are fatty (5.7 percent or more fat) the procedure is described in Fig. 5. The fresh fish must be split from the back to facilitate evisceration and to give a higher surface to volume ratio for easy drying.

Figure 6 shows the recommended procedure for lean and large fish. It follows closely the Cavite procedure except that the fish undergo brine-soaking to increase salt absorption. For very large, thick fish, the cooking time must be increased to about 20 to 30 minutes. Smoking can then be carried out in a relatively cool oven.

Improved methods of handling and storing of smoked fish

Moisture and salt content play an important role in prolonging the shelf-life of smoked fish. Optimum levels of 40 to 50 percent moisture and 6 to 9 percent salt will aid in controlling moulds and prolonging shelf-life. The addition of sorbic acid or potassium sorbate before smoking could also inhibit the mould growth. Rancidity can be inhibited by adding antioxidants such as BHA and BHT. According to Sankaran (1976), BHA was effective in completely inhibiting bacterial growth and the sporulation of toxigenic fungi such as *Aspergillus flavus* and *Aspergillus fumigatus*.

Improper handling and poor sanitation promote rapid deterioration of smoked fish. Minimal handling of the smoked fish should be observed, regular changes of the brine solution, cleaning of trays and the control of flies are also highly recommended.

REFERENCES

- Anderson, C.L. and R.K. Pederson, Salting of other fish. *In* Marine products of commerce. Edited by D.K. Tressler and J. McW. Lemon. New York, Reinhold Inc., pp. 374-417
1951
- Association of Official Agricultural Chemists. Official methods of analysis of the Association of Official Agricultural Chemists. Washington, D.C., AOAC, pp. 327-802
1965
- Avery, A.C., Fish processing handbook for the Philippines. *Res.Rep.U.S.F.W.S.*, (26):46-50
1950
- Deng, J.C., Effect of freezing and frozen storage on salt penetration into fish muscle immersed in brine. *J.Food Sci.*, 42(2):348-51
1977
- FAO, Smoke curing of fish. *FAO Fish.Rep.*, (88):1-7
1970
- Guerrero, C.V. and P.M. Medina, Processing and marketing of smoked fish. Part 2. Southern Tagalog. Quezon City, NFAC, pp. 1-28
1976
- Harrigan, W.F. and M.E. McCance, Laboratory methods in microbiology. London, Academic Press, 362 p.
1966
- IPFC, Fish processing in the Indo-Pacific area. *IPFC Reg.Stud.*, (4):154-7
1967
- Jarvis, N.D., Curing of fishery products. *Res.Rep.U.S.F.W.S.*, (18):185-90
1950
- Mackie, I.M. and B.W. Thomson, Decomposition of trimethylamine oxide during iced and frozen storage of whole and comminuted tissues of fish. Paper presented at the International Congress of Food Science and Technology
1974
- Murray, C.K. and D.M. Gibson, An investigation of the method of determining trimethylamine in fish muscle extract by the formation of picrate salt. Part 1. *J.Food Technol.*, 7(1):35-46
1972
- Mushi, A.M. and H.C. Chiang, Laboratory preservations on the effect of common salt on *Dermestes maculatus* Degeer (*Coleoptera Dermestidae*) infesting dried freshwater fish, *Roccus chrysop.* *J.Stored Prod.Res.*, 10(1):57-60
1974
- National Science Development Board (NSDB), Food composition table recommended for use in the Philippines. Manila, NSDB, Food Nutrition Research Center, pp. 50-60. Fourth Rev.
1968
- Sankaran, R. Comparative antimicrobial action of certain anti-oxidants and preservatives. *J.Food Sci. Technol., India*, 13(4):203-4
1976
- Shewan, J.M., Some of the principles involved in the smoke curing of fish. *Chem.Ind.*, 13:98-101
1945
- A review of the microbiology of frozen and cured fishery products. *Publ.Swed.Inst.Food Preserve Res*, Goteborg, (100):55-100
1954

- Society of American Bacteriologists, Manual of microbiological methods by the Society of American Bacteriologists. New York, McGraw Hill Book Co., Inc.
1957
- Tarlandis, B.G. and M.T. Jounathan, A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J.Am.Oil Chem.Soc.*, 1960:37-45
1960
- Woollen, A. (Ed.), Food industries manual. New York, Chemical Publishing Co. Inc., pp. 213-47, 20th ed.
1970
- Yu, T.C. and R.O. Sinnhuber, 2-Thiobarbituric acid method for the measurement of rancidity in fishery products. 1968 *Food Technol., Aust.*, 12:9-12
- Zaki, M S., Y.M. Hassan and E.H.A. Rahma, Technological studies on the dehydration of Nili Bolti fish (*Tilapia nilotica*) Nahrung, 20(5):467-74
1976

APPENDIX

Name _____

Date _____

Scorecard for Sensory Evaluation of Smoked

Roundskad

Evaluate the quality attributes of the samples according to the rating scales below. Record results in the table. Please write any additional comments about any or all the samples in the back page.

Sample no	Colour	Texture	Saltiness	Smoke flavour	Flavour	General acceptability

Colour, saltiness, smoke flavour

- 7 very excessive
- 6 moderately excessive
- 5 slightly excessive
- 4 just right
- 3 moderately perceptible
- 2 slightly perceptible
- 1 imperceptible

Texture

- 7 very tough
- 6 tough
- 5 very firm
- 4 firm
- 3 soft
- 2 very soft
- 1 mushy

General acceptability

- 9 like extremely
- 8 like very much
- 7 like moderately
- 6 like slightly
- 5 neither like nor dislike
- 4 dislike slightly
- 3 dislike moderately
- 2 dislike very much
- 1 dislike extremely

Application of Gamma Radiation for Disinfestation of Sun-dried Striped Mackerel

by

Ignacio S. Pablo
Philippine Institute of Nutrition, Food Science and Technology
(Philippine Women's University Affiliate)

Abstract

Beetles and flies are serious pests on dried salted fish in the IPFC region. Experiments were conducted to determine the dosage and method of application of gamma radiation as a means of controlling these pests. The effect of ionizing radiation upon the organoleptic quality of the fish was also tested. The optimum doses of gamma radiation for the control of all stages in the life cycles of flies and beetles were determined. The larval and adult stages of *Dermestes* were more resistant to irradiation than the egg and pupal stages. Irradiation at doses of 225 krad was found to have no effect on organoleptic quality.

INTRODUCTION

In the Indo-Pacific region, fish plays an important nutritional role. Fish is available all the year round and is relatively cheap compared with pork, beef and poultry. However, because of the rather crude fishing practices of the region, the freshness of the fish is very much impaired. One effective and efficient preservation technique which may be applied to fish is the use of ionizing radiation in combination with sun-drying and smoking.

Sun-dried fish is very popular and highly acceptable in South East Asia, but the shelf-life is limited to about 6 days under ambient conditions. In an attempt to extend the shelf-life, a study was conducted on the application of gamma radiation using sun-dried mackerel. An optimum dose of 0.1 Mrad extended the shelf-life of the dried mackerel for 3 weeks when the fish were stored at $30 \pm 1^\circ\text{C}$. On the other hand, an extension of 100 days was achieved when the irradiated sun-dried mackerel were stored at $6 \pm 2^\circ\text{C}$. The acceptability of samples irradiated at 0.1 Mrad compared favourably with nonirradiated control (Pablo *et al.*, 1972).

A second major problem in the keeping quality of sun-dried fish is insect infestation. Therefore the study also aimed at investigating the effect of radiopasteurization on insect disinfestation in sun-dried fish. The study focused on the lethal effect of gamma radiation on two insects which are known to be major insect contaminants of sun-dried fish in the region, namely *Dermestes carnivorous* Fabr. and *Parasarcophaga rusicornis* Linn.

The objectives of the study were as follows:

- (1) To determine the efficiency of gamma radiation in controlling the beetle (*Dermestes carnivorous* Fabr.) and the flesh fly (*Parasarcophaga rusicornis* Linn.) on dried, salted, striped mackerel (*Rastrelliger chrysozonous*).
- (2) To determine the effect of ionizing radiation on organoleptic and physico-chemical characteristics of dried salted mackerel.

EXPERIMENTS

Effect of radiation on flies and beetles for the control of flies

Flies were cultured in the laboratory and three-day old larvae were irradiated at low dosages from 0-50 krad. These doses were later increased from 0 to 200 krad for immediate and complete destruction of the flesh fly. The mortality and emergence of pupae were noted. A Cobalt 60 irradiator belonging to the Philippine Atomic Energy Commission was employed

Control of Dermestes carnivorous Fabr.

For naked irradiation, the eggs, larvae, pupae and adult beetles used were 1, 2-6, 12-15 and 15 day old. Doses from 10-20 krad were used for preliminary irradiation of eggs while 200-100 krad were used for the larvae. These doses were later increased to 15-40 krad for the eggs, and to 150-225 krad for the larvae. For the pupae and adults, doses from 10-40 and 175-250 krad, respectively were used. Daily observations were made for mortality, survival, emergence and physical changes.

Mackerel inoculated with larval stage of Dermestes carnivorous Fabr.

The fish were cleaned, leached in 10 percent brine solution for 1 h and soaked in 60 percent saturated brine solution for 3 h to obtain a residual salt content of 17 percent. (Previous studies had shown that the beetle can tolerate salt concentrations as high as 17 percent.). The salted fish were then dried in a hot air cabinet at 70°-75°C for about 9 h to give a moisture content at 30-35 percent. Twenty larvae were inoculated by hand between two pieces of mackerel. The fish were then packed in polyethylene bags and radiation doses between 0 and 200 krad were applied. Moisture and residual sodium chloride contents of the sample were determined.

Evaluation of irradiated dried salted mackerel

Eleven kilogrammes of striped mackerel were salted using 60 percent supersaturated brine, they were then dried in a solar polythene drier for about 16 h to obtain the desired moisture content of 30-50 percent. Two pieces of dried salted mackerel were packed in polyethylene bags and irradiated at 225 krad (this level was found to be destructive for the beetle). Both irradiated and nonirradiated samples were stored at room temperature and examined visually for growth of mould and other signs of spoilage at weekly intervals. The following tests were also conducted:

- (1) *Sensory evaluation.* The samples were fried for 5-8 min or until the fish was brownish in colour. The samples were coded and served to a taste panel consisting of 10 members. A 9-point hedonic scale for acceptability and 7-point hedonic scale for colour, texture, flavour and odour were used.
- (2) *Physico-chemical analysis.* (a) pH—the hydrogen ion concentration of the sample was determined with the aid of a Beckman pH meter (model 96). A 10-g sample was blended with 10 cm³ of distilled water; (b) Peroxide value (Jacobs, 1950); (c) (TVB) Total volatile bases (Sinhuber *et al.*, 1966).
- (3) *Microbial analysis (mould and yeast).*

RESULTS AND DISCUSSIONS

Effect of radiation on flies and beetles

Control of flies

Parasarcophaga rusicornis Linn. (flesh fly) was found to be the predominant insect infesting salted mackerel during dehydration.

Irradiation of the larval stage of the flesh fly at 20, 30, 40 and 50 krad failed to kill all the insects. Larvae irradiated at 50 krad had a 100 percent mortality 12 days after exposure to gamma radiation. Pupae emerged after treatment at 20, 30 and 40 krad but there was a delay in pupation compared with the unirradiated larvae. Percent pupation for 10, 30 and 40 krad was 57, 37 and 10 percent respectively. No pupation was noted for larvae irradiated at 50 krad.

When doses were increased to 150, 175 and 200 krad it was found that all larvae were killed at 100 krad 5-6 h after exposure. Those exposed to 150 krad died 4 days after exposure and after 3 days for samples irradiated at 175 krad (Table 1). Loaharanu (1973) found that about 225 krad was required to prevent 99 percent of larvae (cheese skipper) from developing into pupae. The bodies of the larvae were discoloured and reduced in size after exposure to irradiation and two or three days after irradiation the surviving larvae became very inactive. Highly significant differences were found between treatments on the mortality of the larvae. Higher doses gave higher mortality.

Table 1

Irradiation of the larval stage of flesh fly^{a/}

Dose (krad)	% Mortality (days after irradiation)											
	0 days			1 day			2 days			3 days		
	I	II	III	I	II	III	I	II	III	I	II	III
0	0	0	0	3	0	0	0	0	0	7	0	3
150	27	20	23	87	73	70	100	77	80	100	93	97
175	67	73	40	100	97	90	100	100	93	100	100	100
200	100	100	100									

a/ average of 3 exposures

Table 2

Effect of gamma radiation on the eggs of
Dermestes carnivorous Fabr. ^{a/}

Dose (krad)	% Emergence 2 days after irradiation			% Mortality of larva which emerged from irradiated eggs (days after irradiation)											
				2 days			3 days			4 days			5 days		
	I	II	III	I	II	III	I	II	III	I	II	III	I	III	III
0	90	80	80	0	0	0	0	0	0	22	25	38	22	25	50
15	25	10	30	0	0	0	0	0	67	80	0	83	100	100	100
20	5	10	10	0	50	50	100	100	100						
25	5	20	5	100	100	100									
30	0	0	0												
35	0	0	0												
40	0	0	0												

a/ average of 2 exposures

Table 3

Irradiation of the naked larval stage of
Dermestes carnivorous Fabr. ^{a/}

Dose (krad)	% Mortality (days after irradiation)											
	0 days			1 day			2 days			3 days		
	I	II	III	I	II	III	I	II	III	I	III	III
0	0	0	0	5	15	15	5	15	15	15	15	15
150	10	28	16	70	84	78	85	95	95	100	100	100
175	16	34	15	100	95	85	100	100	100			
200	84	70	65	100	100	100						
225	100	100	100									

a/ average of 2 exposures (3 replications per exposure)

Control of *Dermestes carnivorous* Fabr.

Irradiation of the four developmental stages of the beetle indicated that mortality and emergence are related to the dosage used. Larvae which emerged from eggs irradiated at 0–20 krad were found in the dried salted mackerel but reduced emergence was noticed in eggs exposed to 25 krad. As shown in Table 2, a dose of 30–40 krad caused 100 percent destruction.

Larvae irradiated at 200 to 100 krad were active 3 or more days after irradiation. However, the irradiated larvae did not develop into the next stage. They died slowly due to dehydration. Immediate destruction of the larvae was achieved at 225 krad (Table 3) while larvae exposed at 200 krad all died one day after irradiation.

Tables 4 and 5 show the results of adult emergence and mortality from pupae. Two to six-day old pupae irradiated at 0–40 krad emerged into adults. However, pupae irradiated at 40 krad were weak, with deformed wings and feet. For two-day old pupae irradiated at 30–60 krad, complete mortality and no emergence were obtained.

Results on the irradiation of naked adults are shown in Table 6. A dose of 250 krad killed the adults immediately but at a dose of 200 krad, adults were still capable of feeding.

The eggs and pupae were more susceptible than the larval and adult stages of the beetle. Highly significant differences were observed, both at 0.05 and 0.01 levels, on the mortality of the four stages of the beetle subjected to different treatments.

Mackerel inoculated with larval stages of *Dermestes carnivorous* Fabr.

Dried salted mackerel, inoculated with the larval stage of the beetle, were exposed to gamma radiation, the same doses as used for the naked irradiation of larvae. Results of these tests are given in Table 7. Irradiation had the same effect as on the naked larvae; at 175 krad there was a 28 percent mortality immediately after irradiation. However, the remainder fed actively initially but all were dead only two days after irradiation. Inoculated larvae irradiated at 200 krad were all dead one day after irradiation. Significant differences were noted between each treatment.

Evaluation of irradiated dried salted striped mackerel

A polythene tent drier was used instead of the air cabinet drier. This drier has been established as an effective method of disinfestation and of enhancing drying time (Doe *et al.*, 1976).

Sensory evaluation

Dried salted mackerel were irradiated at 225 krad; the dose required for immediate and complete destruction of larval and adult stages of the beetle. The samples were stored at $30 \pm 2^\circ\text{C}$ for a period of 49 days. The panel of tasters scored the samples as 'very good' (5.5 to 5.9) for odour, colour, flavour and texture. Storage time affected the texture and colour of the fish. The difference in colour may be attributed to cooking time; the long storage time may make the fish less firm.

Irradiated striped mackerel compared very favourably with the nonirradiated striped mackerel. Mean scores obtained for treated and untreated samples were 6.9 and 6.7 respectively. Analysis of variance showed no significant difference between the samples. This result confirms the findings of Metlistkit (1968) that irradiation at doses up to 500 krad does not alter the organoleptic properties of the product.

Physico-chemical analyses

The pH value of the sample varied from 6 to 5.8; the pH was stable throughout the storage period. The pH values obtained in this study agreed with those of Pablo *et al.*, (1972).

Peroxide values of the control samples ranged from 18 to 262 and the irradiated samples ranged from 35 to 274. Although peroxide values from 33 to 201 are considered extremely rancid (Jacobs, 1950), the organoleptic qualities of the samples were not affected by rancidity during storage as shown by sensory evaluation results.

TVB values increased gradually during storage from 0.953 to 6.16 and 0.732 to 5.58 mg percent for control and irradiated samples respectively. Both irradiated and unirradiated products were considered edible after 49 days of storage.

Table 4

Effect of radiation on emergence of pupae of
Dermestes carnivorous Fabr.

Dose (krad)	% Emergence (days after irradiation)														
	0 days			1 day			2 days			3 days			4 days		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
0	50	17	50	50	17	67	50	17	67	67	67	83	83	67	83
10	0	7	0	0	17	0	33	17	17	50	50	33	50	50	30
20	0	7	0	33	17	17	33	33	17	50	33	50	50	33	50
30	0	0	0	0	0	0	0	33	17	0	33	17	0	33	17
40	0	0	0	0	0	0	0	0	17	0	0	17	0	0	17

Table 5

Effect of radiation after emergence from pupae on
adult mortality of *Dermestes carnivorous* Fabr.

Dose (krad)	% Adult mortality from pupae (days after irradiation)														
	5 days			9 days			13 days			23 days			33 days		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
0	0	0	0	0	0	0	0	0	0	0	0	0	20	25	20
10	0	0	0	0	0	0	0	0	0	33	67	50	100	100	100
20	0	0	0	0	50	0	67	50	67	67	50	67	100	100	100
30	0	0	0	0	50	50	a/	100	100						
40	a/	a/	100												

a/ no adult beetle emerged from pupa

Table 6

Effect of irradiation on adults of *Dermestes carnivorous* Fabr.

Dose (krad)	& Mortality (days after irradiation)								
	0 days			1 day			2 days		
	I	II	III	I	II	III	I	II	III
0	0	0	0	0	0	0	0	0	0
175	0	0	0	40	40	60	100	100	100
200	60	40	60	100	100	100			
225	100	80	80	100	100	100			
250	100	100	100						

Table 7

Irradiation of dried salted striped mackerel inoculated with larve of *Dermestes carnivorous* Fabr.

Dose (krad)	% Mortality (days after exposure)														
	0 days			1 day			2 days			3 days			3 days		
	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
0	0	0	0	0	10	10	10	10	10	10	10	20	10	10	20
150	0	0	0	50	0	57	80	57	71	90	86	100	100	100	100
175	11	44	30	100	100	100									
200	90	100	60	100	100	100									

Microbial analyses (mould and yeast count)

The unirradiated samples had consistently higher mould and yeast counts than the irradiated samples except on the 7, 42 and 49 days storage period when the counts were the same for both samples. Higher counts were recorded with increased storage time. The microbial load of the irradiated sample increased from 0 to 100 organisms/g after 49 days of storage. Visual inspection showed no detectable traces of moulds and yeasts on both irradiated and unirradiated samples after 49 days of storage.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations may be derived:

- (1) The optimum irradiation dose for the immediate and complete destruction of the larval stage of the flesh fly was 200 krad although 50 krad was sufficient to kill the larvae within 12 days.
- (2) The optimum dose of gamma radiation for the complete and immediate control of the four developmental stages of *Dermestes carnivorous* was 30, 200, 40 and 225 krad for eggs, larvae, pupae and adult stages respectively
- (3) The larval and adult stages of *Dermestes carnivorous* Fabr. were more resistant to irradiation than the egg and pupal stages.
- (4) Irradiation at a dose of 225 krad gave no detectable difference in terms of organoleptic qualities between treated and untreated dried salted striped mackerel.
- (5) Studies on packaging materials, which can withstand insect damage, must be conducted to prevent recontamination of the treated product.

ACKNOWLEDGEMENT

The research project entitled Radiation Disinfestation of Sundried Striped Mackerel was assisted financially by the International Atomic Energy Agency under contract No. 1475/RB,

REFERENCES AND RELATED LITERATURE

- Burgess, G.H.O. *et al.* (eds.), Fish handling and processing. Edinburgh, H.M.S.O., 309 p.
1965
- Cutting, C.L. and J.J. Waterman, Fish handling and processing. Chem.Publishing Co. N.Y.
1967
- Daget, J., Insect infection of African dried or smoked fish and the possibility of its control by irradiation. *Tech. Rep.Ser.IAEA*, (54):73-83
1966
- Derosier, H.W. and N.M. Rosenstock, Radiation technology in food, agriculture and biology. Westport, Conn.,
1960 AVI Publishing Co., Chapter 14
- Doe, P.E.A. *et al.*, A polythene tent drier for improved sundrying of fish. Bangladesh, Cox's Bazar, December
1977 (Repr.)
- Frazier, W.C., Food microbiology. New Delhi, Tata McGraw-Hill, Co.
1976
- Jacobs, M.B., The chemical analysis of food and food products. New York, Van Nostrand Co.
1950
- Loaharanu, P. *et al.*, Preservation of fishery products by ionizing radiation with special reference to boiled chub
1973 markerel. *In* Radiation preservation of foods. *Proc.Ser.IAEA*. (STI/PUB/317):427-40
- Metlitskii, L.V. *et al.*, Disinfestation of dried and smoked fish. *Rad.Process.FoodProd.*, 23(7)
1968

- Morrison, P.E. and D.M. Davies, Feeding of dry chemically defined diets, and egg production in the adult house fly. *Nature, Lond.*, 201:104-5
1964
- Murray, C.K., D.M. Gibson and J.M. Shewan, Quality control aspects of pre-packed fresh and smoked fish. *In* 1971 Fish inspection and quality control, edited by R. Kreuzer. London, Fishing News (Books) Ltd., for FAO, pp. 66-70
- Pablo, I.S., R.T. Fernandez and C.Q. Coronel, The effect of radio-pasteurization on the organoleptic physico-chemical and storage life extension of dried striped mackerel stored at 30±1°C and 6±2°C. IAEA Research Contract 781/RC Phil.
1972
- Philippines, Bureau of Fisheries and Aquatic Resources, Fisheries statistics of the Philippines. *Fish.Stat.Philipp.*,
1975 (1975)
- Sinnhuber, R.C. *et al.*, Radiation sterilized sea food products. *In* Processing food irradiation, Vienna, IAEA
1966
- Spiller, D., Procedure for rearing houseflies. *Nature, Lond.*, 199:405
1963
- Spinelli, J. *et al.*, Quality inducer that can be used to assess irradiated seafoods. Seattle, Washington, Bureau of
1967 Commercial Fisheries Technological Laboratory, 568 Draft I
- Thomou, H., Sterilization of *Dacus oleae* by gamma radiation. *In* Radiation and radioisotopes applied to insects
1963 of agricultural importance. *Proc.Ser.IAEA*, (STI/PUB/74):413-21
- Viado, G.B. and E.C. Manoto, Effects of gamma radiation on three species of Philippine insect pests. *In* Radiation and radioisotopes applied to insects of agricultural importance *Proc.Ser.IAEA*, (STI/PUB/74):
1963 443-54

SESSION

IV

SESSION IV

FISH MARKETING AND QUALITY ASSURANCE

CONTENTS

SEAWEEDS AS FOOD	
by R. Kikuchi and S. Hirao	412
TOXINS OCCURRING IN COMMERCIALY IMPORTANT MARINE ORGANISMS	
by K. Hashimoto and N. Gusetani	416
POST-HARVEST HANDLING AND MARKETING OF FRESHWATER FISH IN HONG KONG	
by K.W.J. Cheng	425
A NOTE ON FISH INSPECTION IN THE PHILIPPINES	
by C.D. Balista	431
FISH INSPECTION AND QUALITY CONTROL OF FISH EXPORTS FROM THE PHILIPPINES	
by Casimiro D. Balista and Josefina G. Santos	433
FISH CONSUMPTION TRENDS IN INDIA	
by K.K. Balachandran, P.A. Perigreen and M.R. Nair	435
MARKETING OF FRESH MARINE FISH IN HONG KONG	
by K.W. Chan and N.K. Lee	439
ACCEPTABILITY OF MALAYSIAN FISHERY PRODUCTS	
by Asiah M. Zain	444
MEASURING THE QUALITY AND ACCEPTABILITY OF FISH PRODUCTS	
by P. Howgate	449
MARKETING INFORMATION AND ADVISORY SERVICE FOR FISH PRODUCTS IN THE ASIAN REGION	
by Fish Utilization and Marketing Service, Fisheries Department, FAO	462
EVALUATION OF THE KEEPING QUALITY OF SMOKED FISH	
by M.B. Adebona	465
PROCESSING AND MARKETING OF DRIED FISH IN CEBU AND BOHOL, PHILIPPINES	
by Cezar V. Guerrero	468

SEAWEEDS AS FOOD

by

R. Kikuchi and S. Hirao

Tokai Regional Fisheries Research Laboratory

Tokyo, Japan

Abstract

Seaweeds contain vitamins and minerals in desirable proportions and, because the digestibility of the carbohydrate is usually low, make a good roughage. Annual consumption of algae is estimated, on a dry basis, as 30 000 t for *Porphyra*, 28 000 t for *Undaria* and 26 000 t for *Laminaria*. Nearly all the *Porphyra* and *Undaria* production is cultivated and comes mostly from the Pacific coast. *Laminaria* is collected wild although its cultivation has been encouraged in recent years. In Japan, the supply of *Porphyra* comes from local production; other algae are imported. Seaweed in Japanese recipes has, traditionally, been eaten with rice and the demand for seaweed seems to be linked to the demand for rice. In the past three decades, the demand for rice has remained constant or even decreased as a result of the westernization of Japanese eating habits. To encourage the increased consumption of seaweed, more basic research should be carried out on the incorporation of seaweed into modern recipes. Algae seem to be particularly suitable for culinary usage, provided their useful components can be extracted economically.

INTRODUCTION

The Japanese are unique in eating many kinds of seaweeds almost daily. As early as 927 A.D. seaweed was known as one of the nine important foods dedicated to the gods. Table 1 shows the nutritive composition of the seaweeds which are commonly eaten. The calorie value is unknown because there is insufficient information on the digestibility by humans of glucose, arabinose, xylose, rhamnose, galactose, etc. and their complicated polymers which comprise most of the seaweed. As a rough estimate, the digestibility of carbohydrates in seaweed is one half to two thirds of that of starch and allied sugar complexes contained in cereals and vegetables. The agar consists of agarose and agaropectin and is not digested by humans.

The *Porphyra* contain the highest amount of protein; about 40 percent on a dry weight basis. The other seaweeds contain from 7 to 15 percent. Seaweeds are rich in amino acids particularly glutamic acid, alanine, glycine, aspartic acid, proline and threonine with small amounts of tryptophan (Table 2). This amino acid composition is similar to vegetables. The fat content is generally low and seaweed cannot be considered as a source of fat or fat soluble vitamins. Water soluble vitamins are easily extracted; this suggests that their nutritional availability may be rather high. *Porphyra* is particularly rich in riboflavine. The following minerals, with some other minor constituents, have been reported: Na, K, Ca, Ni, Li, Mo, Zn, Cu, Mg. *Hizibia* contains the greatest quantity of iodine followed by *Laminaria*, *Undaria*, *Porphyra* and *Ulva* in that order. About 20 percent of the minerals is water soluble and thus more available for nutrition. The above considerations indicate that seaweed is valuable as a source of vitamins and minerals as well as being a good roughage. However, it is not an important source of calories (Table 2).

As seaweed is normally eaten with rice, consumption of both is closely related. Japan has the potential for a greater production of seaweeds as they are easily cultivated around the coast. However, production has not increased due to lack of demand. *Porphyra*, *Undaria* and *Laminaria* are the most popular of Japanese seaweeds.

Laminaria grows abundantly in the wild around the coast of Hokkaido. Japan formerly had a large catch but in recent years, due to political difficulties, the landings have decreased to 158 000 t wet basis annually. *Laminaria japonica* is considered to have the highest quality among the *Laminaria* species. It is cultured along the Pacific coast although the quality is not as good as that collected from the wild. *Laminaria* is eaten in many ways. It is dried in the sun immediately after harvesting and then sent to market. It can be cut into small pieces, cooked and seasoned with soy sauce (tsukadani), cut into larger pieces and rolled with pieces of dried fish and then cooked (kobumaki), shavings (tororokombu), softened with vinegar (su-kombu), powdered to make a drink like tea (kombu-cha), etc. Because it is rich in glutamic acid, *Laminaria* is also used to season soups and other dishes.

Table 1
Food composition edible seaweed marketed in Japan

Item	Water (%)	Protein (%)	Fat (%)	Carbohydrate (%)		Ash (%)	Minerals				Vitamins							
				Sugar Substance	Fibre		(Ca)	(Na)	(P)	(Fe)	A			D	B ₁	B ₂	Nicotinic Acid	C
											A Activity	A	Carotene					
<i>Ulva lactuca</i>	15.2	23.8	0.6	42.1	4.6	13.7	730	—	230	87	500	0	1 500	0	0.04	0.52	10.0	10
<i>Enteromorpha compressa</i>	3.7	20.7	0.3	61.5	7.2	6.6	600	—	220	106	960	—	2 900	0	0.06	0.30	8.0	10
<i>Porphyra tenera</i>	11.4	35.6	0.7	39.6	4.7	8.0	260	600	510	12	11 000	0	33 000	0	0.25	1.24	10.0	20
<i>Laminaria japonica</i>	14.7	7.3	1.1	51.9	3.0	22.0	800	2 500	150	—	430	0	1 300	0	0.08	0.32	1.8	11
<i>Laminaria longissima</i>	15.8	6.9	1.3	38.0	10.8	27.2	—	—	—	—	250	0	750	0	0.08	0.40	1.8	—
<i>Laminaria ochotensis</i>	18.1	6.9	1.7	46.9	4.7	21.7	750	—	170	10	320	0	960	0	0.06	0.09	2.0	15
<i>Laminaria angustata</i>	18.0	6.7	1.6	49.1	5.4	19.2	850	—	180	10	360	0	1 100	0	0.02	0.20	2.0	—
<i>Laminaria religiosa</i>	16.3	6.0	0.3	41.5	6.7	29.2	1 200	—	280	10	130	0	390	0	0.07	0.19	3.5	—
<i>Kjellmaniella gyrata</i>	28.5	5.2	0.7	40.3	9.5	15.8	740	1 900	150	5	10	0	30	0	0.04	0.14	2.3	)
<i>Phyllocladus sacrum</i>	6.5	25.1	0.1	60.1	1.2	7.0	1 700	—	150	140	160	0	490	0	0.22	0.37	1.7	0
<i>Gelidium jelly</i>	99.0	0.1	0	0.8	0	0.1	220	3 900	110	12	10	0	30	0	0.07	0.16	1.0	0
<i>Hizikia fusiforme</i>	16.8	5.6	0.8	29.8	13.0	34.0	1 400	—	56	29	150	0	450	0	0.01	0.20	4.0	0
<i>Monostroma nitidum</i>	10.0	14.4	0.2	59.8	4.8	10.8	890	—	550	10	60	0	180	0	—	—	3.3	0
<i>Nemacystus decipiens</i>	73.9	0.7	0.4	0.6	—	24.4	190	—	44	4	30	0	160	0	0.04	0.04	2.0	0
<i>Undaria pinnatifida</i>	16.0	12.7	1.5	47.8	3.6	18.4	1 300	2 500	260	13	140	0	440	0	0.11	0.14	10.0	15

Table 2

Essential amino acid and protein scores of seaweed

Item	Ile	Leu	Lys	Met	Cys	Met + Cys	Phe	Tyr	Phe + Tyr	Thr	Trp	Val
<i>Porphyra tenera</i>	99	191	64	83	35	118	131	60	191	79	27	230
<i>Laminaria japonica</i>	101	162	79	48	44	92	223	101	224	79	48	215
<i>Hizikia fusiforme</i>	143	165	66	73	29	102	132	70	202	73	17	231
<i>Undaria pinnatifida</i>	78	230	100	56	25	81	100	43	143	148	32	187
	Protein score			Egg score		Human milk score						
	A/E Ratio			FAO		Japan						
<i>Porphyra tenera</i>	59 L ^{1/}		48 L			51 L		44 L		50 L		44 L
<i>Laminaria japonica</i>	67 L		59 L			63 L		54 L		61 L		54 L
<i>Hizikia fusiforme</i>	52 T ^{2/}		38 T			53 L		46 L		50 T		46 L
<i>Undaria pinnatifida</i>	67 I ^{3/}		58 I			60 I		65 S ^{4/}		60 I		69 L
Pumpkin	45 S		51 S			64 S		54 S		77 S		78 Th ^{5/}
Carrot	25 S		43 S			53 S		46 S		65 S		75 S
Spinach	23 S		24 S			30 S		26 S		36 S		42 S
Turnip	22 T		27 T			39 T		36 T		35 T		34
Cabbage	47 T		58 T			84 T		75 S		76 T		73 Le ^{6/}
Cucumber	34 S		32 S			40 S		34 S		49 S		57 S

1/ Lysine 3/ Isoleucine 5/ Threonine

2/ Tryptophan 4/ Methionine + cystine 6/ Leucine

Undaria landings annually are 140 000 t on a wet basis. Nearly 90 percent is cultured along the Pacific coast of north Honshu. The demand has not increased because of the limited number of users. Raw fronds of *Undaria* are dipped in boiling sea water immediately after landing for about a minute to kill the enzymes. They are then mixed with salt and stored in a cool place until being sent to market. Raw *Undaria* is also dried in the sun before storage or sprinkled with ashes to dry it so that the quality is little changed during storage through the summer. Recipes for *Undaria* are confined to use either as an ingredient in soup or sour-salad. *Porphyra* has a long history of cultivation and *P. gezoensis* and *P. tenera* are the species cultivated; the former being most important. In addition to the wild form, some selected forms have appeared and are used by culturists. Annual production is 30 000 t on a dry basis. Harvested raw fronds from the sea are finely cut and dried in the shape of a thin flat sheet which is bundled and sent to market. It keeps its quality for months if kept well dried. The product is almost invariably eaten wrapped around boiled rice, either in the shape of a ball or a cylinder, with some salty ingredients in the centre. These products are easy to carry to the office, school etc. for lunch. They are the equivalent of hamburgers or sandwiches in the western world.

Ulva lactuca and *Enteromorpha compressa*, though demand is rather small, are dried, scorched, powdered and used as spices to season various foods. *Hizikia* is noted for its very high content of iron, although no studies have been undertaken regarding its availability to humans. *Hizikia* is cooked with soy sauce and eaten with rice. *Monostroma nitidum* is cooked with seasoned soy sauce into a thick paste to be eaten with boiled rice. *Nemacystus decipiens* is eaten mostly as sour-pickles. *Phyllocladus* *sacrum* is a freshwater alga with similar components to *Spirulina*, which has been reported as a potential new protein source for tropical countries. *P. sacrum* is eaten in a similar way as *Porphyra*.

Other than for human food, seaweeds may be used as a feedstuff for livestock and aquatic animals. Waste material as well as some inedible seaweeds are used to rear abalone. However, there has been little research and development on the use of seaweed for livestock feeding. With the considerable potential for an increase in production, new methods of processing and a wide range of recipes should be developed. There may also be considerable opportunities for introducing seaweed as a food in countries where the people are not accustomed to it.

TOXINS OCCURRING IN COMMERCIALY IMPORTANT MARINE ORGANISMS

by

K. Hashimoto and N. Fusetani
Laboratory of Marine Biochemistry
University of Tokyo
Tokyo, Japan

Abstract

Thousands of aquatic animal species, some of which affect our lives directly and/or indirectly, have been listed as poisonous or venomous. Marine animals which are important as food sources in the Indo-Pacific region often cause poisoning. Puffer fish poisoning, ciguatera poisoning and paralytic shellfish poisoning present the most serious problems for the fishing industry, as well as for the food hygienist and have been studied extensively for the past twenty years. Poisonings from fish roes and wax-rich fish are also worthy of note. Marine toxins are known to be synthesized by the causative organisms or to be accumulated through food chains; they are not bacterial in origin. On the other hand, some marine organisms are known to cause environmental damage such as mass mortalities of commercially important fish and shellfish. In this review, the current state of our biological and chemical knowledge of these toxins is presented.

INTRODUCTION

Marine organisms have been a source of food for human beings from the dawn of history. In recent years, the rapid growth of the world's population has caused us to pay more attention to marine fauna and flora as food and to utilize hitherto unexploited species.

Thousands of marine organisms have been listed as poisonous or venomous, some of which cause discomfort, illness or even death in man (Halstead, 1965, 1967, 1970). More and more toxic species will be found as fishing activities increase and it is therefore very important to accumulate a knowledge of toxic species and their toxic factors, in order to utilize marine food sources more efficiently and to safeguard human health. We must also pay attention to the increasing number of red-tide outbreaks which have caused losses of commercially important fish and shellfish. However, little is known of the red-tide organisms and their toxins (Fusetani, 1976).

In this review, the current state of our knowledge of toxins in marine organisms will be discussed. Emphasis will be given to toxins isolated from fish and shellfish which are valuable food sources.

TOXINS FROM FISH

Tetrodotoxin

Poisoning from puffer fish is perhaps the best documented marine intoxicant. Historically, human poisoning was reported in the Chinese medical literature 2 000 years ago (Tsuda, 1966). Puffer fish poisoning has been a public health problem in Japan because 'fugu' (puffer fish) is a culinary delicacy. Many incidents of puffer poisoning have occurred and even now, although only licensed cooks may prepare fugu dishes in restaurants, around 100 people are poisoned every year (Halstead, 1967).

The toxic principle, tetrodotoxin, appears to be concentrated mainly in the ovaries and liver of some species belonging to the Tetraodontidae (Halstead, 1967). It is noteworthy that some tropical puffers (e.g., *Lagocephalus lunaris lunaris*) possess a high concentration of the toxin in the muscle (Berry and Hassan, 1973). The pure tetrodotoxin was first isolated in 1948 by a Japanese chemist. After extensive studies the structure of

tetrodotoxin (Appendix 1) was elucidated in four laboratories simultaneously in 1964 (Tsuda, 1966; Goto *et al.*, 1965; Woodward, 1964; Mosher *et al.*, 1944). Tetrodotoxin is a weakly basic (pKa 8.5) compound with a composition $C_{11}H_{17}N_3O_8$. It shows novel structural features; only one carbocyclic ring, a guanidine moiety, six hydroxyl groups and an unprecedented hemilactal function. A total synthesis of tetrodotoxin has been accomplished by Kishi *et al.*, 1972.

Tetrodotoxin has been isolated from several unrelated animal species. Moguchi and Hashimoto (1973) isolated the toxin from the goby, *Gobius criniger*, which has caused human poisoning in the Philippines and in Taiwan. Mosher's group (1964) reported that the toxic principle, originally named taricha-toxin, found in the eggs of the California newt, *Taricha torosa* was identical to tetrodotoxin. More recently, they have detected tetrodotoxin in the skin of Costa Rican frogs of the genus *Atelopus* (Kim *et al.*, 1975). The wide distribution of tetrodotoxin in phylogenetically unrelated animals is puzzling when the biogenesis of the toxin is considered.

Symptoms of puffer fish poisoning are numbness and tingling of the lips, tongue and mouth, nausea, vomiting, diarrhoea and in severe cases, respiratory paralysis followed by death. The mortality rate has been estimated to be greater than 60 percent. The pure tetrodotoxin shows a toxicity of LD_{50} 9 μ g/kg in mice. It appears to block nerve conduction by specifically interfering with the initial passive increases in sodium permeability of the membrane (Narahashi, 1972). Tetrodotoxin has become an indispensable pharmacological reagent in understanding the mechanism of membrane permeability. No specific antidote or recommended specific treatment for the poisoning is known as yet.

Ciguatera toxins

Ciguatera food poisoning is caused by ingestion of a large variety of sub-tropical and tropical fish associated with coral reefs, but rarely of coral reef invertebrates (Halstead, 1967). Outbreaks of ciguatera have been reported from various areas in the Caribbean, Pacific and Indian oceans where many ciguateric fish are commonly eaten. Therefore, the problem of ciguatera is of paramount importance in public health terms.

Symptoms of ciguatera have neurological and gastrointestinal phases which include tingling of the lips, mouth and fingertips, itching of the skin, reversal of temperature sensation, loss of motor ability, vomiting and diarrhoea. The disease is rarely fatal but is prolonged; recovery may take months (Bagnis, 1968). It has also been observed that a person who has suffered from ciguatera becomes somehow sensitized so that he may exhibit symptoms even if he eats non-toxic fish.

A large number of fish have been listed as causing ciguatera. Halstead (1967) listed well over 400 species but Bagnis (1967), who surveyed ciguatera in French Polynesia, considered 32 species in 15 families to have produced the disease. In general, ciguateric species are limited to those fish that feed on algae or detritus on coral reefs and the larger reef carnivores that prey on these herbivores. They mostly belong to the Acanthuridae, Scaridae, Carcharhinidae, Muraenidae, Carangidae, Labridae, Lutjanidae, Lethrinidae, Serranidae and Sphyraenidae. At present, it is generally accepted that the principal toxin in these ciguateric fish is ciguatoxin which was isolated and named by Scheuer *et al.*, (1967). The species of fish in which the presence of ciguatoxin has been confirmed experimentally are few but include such important species as the red snapper, *Lutjanus bohar*; moray eel, *Gymnothorix javanicus*; amberjack, *Seriola aureovittata*; grouper, *Epinephelus microdon*; parrotfish, *Scarus gibbus*; shark, *Carcharhinus menisorrh* and surgeonfish, *Ctenochaetus striatus* (Scheuer *et al.*, 1967; Hashimoto and Fusetani, 1968; Yasumoto *et al.*, 1971; Chanteau *et al.*, 1976; Chungue *et al.*, 1977).

Ciguatoxin has not yet been obtained in pure form but the most purified preparation showed a toxicity of 8 μ g/kg in mice (Chanteau *et al.*, 1976). Little is known of the structural features; a hydroxylated lipid molecule of approximate molecular weight 1 500 (Scheuer, 1977). The toxin is positive to Dragendorff reagent. Ciguatoxin has a rather widespread action on excitable membranes involving an initial increase in excitability followed by conduction block; this might be explained by an increase of sodium ion permeability. This action is antagonized by either tetrodotoxin or calcium ions (Banner, 1976).

Numerous difficulties prevent development of anti-ciguatera measures. The major difficulties are:

- (a) No simple and reliable bioassay method has been developed (currently, feeding tests on cats or mongooses are adopted)
- (b) Variability of toxicity in ciguateric fish is extremely high
- (c) Isolated geographic distribution of toxic fish (fish can be toxic at one reef and not at another a short distance away)
- (d) Fish become toxic sporadically, unpredictably and suddenly (Banner, 1976)

The phenomena listed above support the food chain hypothesis originally advanced by Randall (1958). Over the years, many organisms have been suggested as the original elaborator of the toxin. Quite recently, Yasumoto and collaborators (1977) reported that the dinoflagellate *Diplopsalis* sp. nov, collected from detritus on the coral reefs of French Polynesian islands produced ciguatoxin and maitotoxin. It would seem reasonable to assume that this organism is picked up concomitantly by herbivorous animals and the accumulated toxin is then transmitted to carnivores.

The complexity of clinical symptoms of ciguatera poisoning indicates that toxins other than ciguatoxin are involved in ciguateric organisms (Hashimoto, 1976). Recently, a fat-soluble secondary toxin, named scaritoxin, has been isolated along with ciguatoxin from the muscle of the parrotfish, *S. gibbus*, which frequently causes human poisoning in French Polynesia (Chungue *et al.*, 1977). Scaritoxin occurs as the major toxin in the muscle of *Scarus* spp. and shows a close similarity to ciguatoxin in biological and chemical properties. Yasumoto and co-workers (1971, 1976) isolated three toxins, ciguatoxin, maitotoxin and an unknown toxin, from the viscera and gut contents of the herbivorous surgeonfish, *C. striatus*, the most well-known ciguateric species in Tahiti. Maitotoxin reveals a lipoproteinic nature and gives rise to fatty acids, sugars and 15 amino acids on hydrolysis. It is toxic to guppies as well as to mice (MLD 15-20 mg/kg). Ciguatoxin, scaritoxin and maitotoxin were also found in the viscera of the turban shell, *Turbo argyrostoma*, which provoked ciguatera-like poisoning in 1968 in Marcus Island (Yasumoto and Kanno, 1976). Palytoxin has been detected in the gut contents and viscera of the filefish, *Alutera scripta*, that was once labelled as a ciguateric fish (Hashimoto *et al.*, 1969; Kimura and Hashimoto, 1973). The toxin was shown to be accumulated by the fish that fed on the toxic zoanthid *Palythoa tuberculosa*.

Dinogunellin

Poisoning caused by eating fish eggs other than the roe of puffer fish is also known. The symptoms are characterized by gastrointestinal disorders including vomiting, diarrhoea and abdominal pain. Halstead (1967) listed over 50 species which cause this disease and suggested the term 'ichthyootoxins' for the causative agents.

In northern Japan, the roe of the northern blenny, *Stichaeus grigorjewi*, has long been known to be toxic and caused a number of human poisonings. The toxic factor, dinogunellin, has been obtained pure and identified as a lysophospholipid (Appendix 1), with a unique structure (Hatano and Hashimoto, 1974; Hatano *et al.*, 1976). Dinogunellin is present in the roe as a lipoprotein. Recently, the toxin in the roe of the cabezon, *Scorpaenichthys marmoratus*, a well known ichthyootoxic species on the Pacific coast of North America, was found to be identical to dinogunellin (Hashimoto *et al.*, 1976). It would be interesting to know whether dinogunellin is common in other ichthyootoxic fish.

Wax esters and diacyl glyceryl ethers

Recent fisheries activities in the deep seas have evoked a new type of poisoning from the consumption of fish flesh, in which non-glyceridic lipids are predominant. These fish, known as 'diving fish' undergo vertical migrations of some hundreds of metres. The castor oil fish, *Lepidocybium flavobrunneum* and *Ruvettus pretiosus*, and lantern fish (family Myctophidae) were shown to have a high oil content in the muscle. The oil consisted predominantly of wax esters (Appendix 1) and produced diarrhoea and seborrhoea in assay animals (Mori *et al.*, 1966; Nevenzel *et al.*, 1969).

On the other hand, stromatid fish such as *Stromateus maculatus*, *Cubiceps gracilis* and *Centrolophus* sp. have been reported to contain high percentages of diacyl glyceryl ethers (Appendix 1); approximately 90 percent of unsaponifiable matters (Mori *et al.*, 1972). Iida (1971) suggested a possible toxicity of diacyl glyceryl ethers. Great care must be taken with the muscle lipids of fish caught by deep sea trawlers.

TOXINS FROM SHELLFISH

Paralytic shellfish poisons

Sporadic outbreaks of poisoning from the ingestion of mussels and clams along the Pacific coast of North America have long been known. From the symptoms, which consist of numbness of lips, tongue and fingertips, muscular incoordination, respiratory distress and death, the intoxication has been called 'paralytic shellfish poisoning' (Halstead, 1970). It was not established until 1939 that molluscs become toxic from accumulation of the toxic red-tide organism *Gonyaulax catenella* (Sommer *et al.*, 1937). The shellfish become too toxic for humans to consume when the dinoflagellates reach a count of 100-200 cells/ml.

The toxic principle, saxitoxin, was first isolated from the Alaskan butter clam, *Saxidomus giganteus* (Schuett and Rapoport, 1962). It was later found to be identical to the toxin obtained from axenic cultures of *G. catenella* and to the toxin from the mussel, *Mytilus californianus* (Schantz *et al.*, 1966). Chemical studies have been made using saxitoxin obtained from cultured *G. catenella*. Saxitoxin is a diacidic base (pKa 8.1, 11.5) of low molecular weight ($C_{10}H_{17}N_7O_4$, M. W 299). The structure (Appendix 1), was first presented by Rapoport's group (Wong *et al.*, 1971), but was later revised by Schantz *et al.*, (1975), who applied x-ray diffraction method to a crystalline bis (*p*-bromobenzenesulfonate)

Saxitoxin has approximately the same lethality as tetrodotoxin (LD_{50} 9 μ g/kg in mice). It acts as a neuromuscular blocking agent and inhibits conductance of sodium ions as does tetrodotoxin (Narahashi, 1972).

Along the North Atlantic coasts of America and Great Britain, blooms caused by the toxic dinoflagellate, *G. tamarensis*, have also presented public health and economic problems. Shimizu and co-workers (1975) recently isolated saxitoxin and three new toxins, gonyautoxins I-III, from cultures of *G. tamarensis* and the soft shell clam, *Mya arenaria*, infested with the dinoflagellate. The structures of gonyautoxins, II and III have been elucidated mainly by spectral data (Shimizu *et al.*, 1976) (Appendix 1). It was quite recently reported that three more toxins, gonyautoxin IV, gonyautoxin V and neosaxitoxin, were detected in *G. tamarensis* (Oshima *et al.*, 1977).

Red tides caused by *Gonyaulax* sp. have been observed recently along the Japanese coast. It was found that the Japanese shellfish poison is a mixture of saxitoxin and five new compounds including gonyautoxins I-III as is the Atlantic poison (Oshima *et al.*, 1976).

Saxitoxin has also been detected in such warm-water organisms as xanthid crab, *Zosimus aeneus*, in the Amami Islands, green turban shell, *Turbo marmorata*, in the Ryukyus and Palauan bivalves (Noguchi *et al.*, 1969; Yasumoto and Kotaki, 1977; Kamiya, personal communication). This may indicate that marine organisms other than *Gonyaulax* spp. produce saxitoxin. It should be noted that paralytic shellfish poisoning occurred in Papua New Guinea, where shellfish were considered to be infested by the dinoflagellate *Pyrodinium bahamense* (Worth *et al.*, 1975).

Surugatoxin

The carnivorous gastropod, *Babylonia japonica*, commonly eaten in Japan, sometimes causes human intoxication, which may be fatal. Symptoms are largely gastrointestinal and neurological. Hashimoto (1968) and Shibota and Hashimoto (1970), found that the toxic extract produced dramatic mydriasis in cats and mice. On purification, a light yellow powder was obtained which evoked mydriasis in mice at a minimum dose of 20 μ g/kg.

Independently of Hashimoto's group, Kosuge and co-workers (1972) succeeded in crystallizing the toxic factor, surugatoxin, as a heptahydrate and determined its structure by x-ray diffraction (Appendix 1). Surugatoxin consists of 6-bromoxyindole, pteridine and myoinositol. It has a strong anti-nicotinic activity on ganglia.

Recently, a gram-positive bacterium (tentatively named F-2), isolated from the bottom mud of the toxic area, was reported to produce a surugatoxin-like substance (Yamamoto *et al.*, 1976). This may suggest that the gastropod becomes toxic by accumulation of the toxic bacterium.

OTHER MARINE TOXINS

Many red-tide organisms are known to produce toxic substance which cause mass mortality of fish or shellfish and shellfish infestations. Most of them belong to the dinoflagellates, among which *Gonyaulax* spp. are most well known.

Another well-known species, *Gymnodinium breve*, which frequently causes massive fish kills along the coast of the Gulf of Mexico, was found to contain a variety of toxic substances (Alam, 1975). Shimizu and co-workers (1976) isolated a pure toxin with an LD₅₀ 0.5 mg/kg (mice) which was considered to be a steroid attached to a large polar moiety. The related species *G. nagasaki*, was reported to cause mass mortality of cultured yellowtail *Seriola quinqueradiata* in Japan (Fusetani, 1976).

The dinoflagellate *Noctiluca miliaris* was found to secrete a large amount of ammonia which causes massive fish kills in Japan (Okaichi and Nishio, 1976). Such toxic dinoflagellates as *Rhodomonas baltica*, *Exuviaella* sp. and *Hornellia* sp. are known to cause mass mortality of fish along the coast of Japan, though their toxic principles are poorly characterized (Fusetani, 1976).

CONCLUSION

Although our awareness of the sea has been rapidly growing, our knowledge of toxic factors in marine organisms lags far behind our knowledge of toxins elaborated by terrestrial organisms. Less than 1 percent of toxic marine organisms has been examined for their chemical properties and pharmacological activities. We need to expand our research effort in this area and increase our basic knowledge of toxic marine flora and fauna in order to utilize marine resources more efficiently.

Recently, another approach has been made toward toxic marine organisms. Exploitation and investigation to develop drugs from the hitherto 'untapped' ocean have been attempted (der Marderosian, 1969). It is natural to consider the vast aquatic environment, in which approximately 80 percent of the earth's animal life lives, as a potential source of drugs. Indeed, many marine toxins isolated so far have remarkable biological activities and chemical properties; some valuable drugs have been developed from them. A new type of insecticide (Cartap) has been derived from the toxin principle (nereistoxin) isolated from the marine worm, *Lumbriconereis heteropoda* (Hashimoto *et al.*, 1973). Tetrodotoxin and saxitoxin are valuable tools in neurophysiology research as pharmacological reagents. (Narahashi, 1972).

In conclusion, we need to accumulate more knowledge of toxic marine creatures.

REFERENCES

- Alam, M., Marine toxins. *Texas Rep.Biol.Med.*, 33:183-99
1975
- Bagnis, R., Les empoisonnements par le poisson en Polynesie francaise: etude clinique et epidemiologique.
1967 *Rev.Hyg.Med.Soc.*, 15:619-46
- _____. Clinical aspects of ciguatera (fish poisoning) in French Polynesia. *Hawaii Med.J.*, 28:25-8
1968

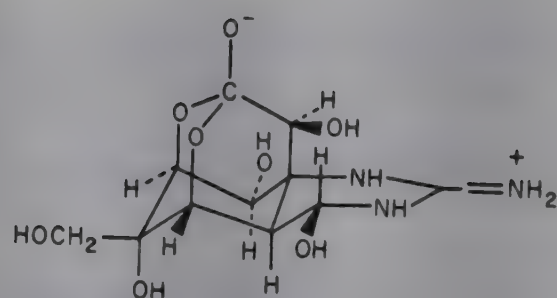
- Banner, A.H., Ciguatera: A disease from coral reef fish. *In* Biology and geology of coral reefs, edited by O.A. Jones and R. Endean. New York, Academic Press, vol. 3:177-213
1976
- Berry, P.Y. and A.A. Hassan, Comparative lethality of tissue extracts from the Malaysian puffer fishes, *Lagocephalus lunaris lunaris*, *L. l. spadiceus* and *Arothron stellatus*. *Toxicon*, 11:249-54
1973
- Chanteau, S., R. Bagnis and T. Yasumoto, Purification de la ciguatoxine de la loche *Epinephelus microdon* (Bleeker). *Biochimie*, 58:1149-51
1976
- Chungue, E. *et al.*, Isolation of two toxins from a parrotfish (*Scarus gibbus*), *Toxicon*, 15:89-93
1977
- Fusetani, N. Red-tide toxins. *Kagaku to Seibutsu*, 14:2-8
1976
- Gogo, T. *et al.*, Tetrodotoxin. *Tetrahedron*, 21:2059-88
1965
- Halstead, B.W., Poisonous and venomous marine animals of the world. Washington, D.C., U.S. Government Printing Office, vol. 1:994 p.
1965
- _____, Poisonous and venomous marine animals of the world. Washington, D.C., U.S. Government Printing Office, vol. 2:1070 p.
1967
- _____, Poisonous and venomous marine animals of the world. Washington, D.C., U.S. Government Printing Office, vol. 3:1006 p.
1970
- Hashimoto, Y. *et al.*, Toxicity of the Japanese ivory shell. *Nippon Suisan Gakkaishi*, 33:661-8
1967
- Hashimoto, Y. and N. Fusetani, A preliminary report on the toxicity of an amberjack, *Seriola aureovittata*. *Nippon Suisan Gakkaishi*, 34:618-26
1968
- Hashimoto, Y., N. Fusetani and S. Kimura, Aluterin: a toxin of filefish, *Alutera scripta*, probably originating from a zoantharian *Palythoa tuberculosa*. *Nippon Suisan Gakkaishi*, 35:1089-93
1969
- Hashimoto, Y., M. Kawasaki and M. Hatano, Occurrence of a toxic phospholipid in cabezon roe. *Toxicon*, 14:141-3
1976
- Hatano, M. and Y. Hashimoto, Properties of a toxic phospholipid in the northern blenny roe. *Toxicon*, 12:231-6
1974
- Hatano, M., R. Marumoto and Y. Hashimoto, Structure of a toxic phospholipid in the northern blenny roe. *In* Animal plant and microbial toxins, edited by A. Osaka *et al.*, New York, Plenum, vol. 2:145-51
1976
- Iida, H. Glyceryl ethers found in *Stromateus maculatus*. *Nippon Suisan Gakkaishi*, 37:338
1971
- Kim, Y.H. *et al.*, Tetrodotoxin: occurrence in atelopid frogs of Costa Rica. *Science, Wash.*, 189:151-2
1975
- Kimura, S. and Y. Hashimoto, Purification of the toxin in a zoanthid *Palythoa tuberculosa*. *Publ. Seto Mar. Biol. Lab.*, (20):713-8
1973

- Kishi, Y. *et al.*, Synthetic studies on tetrodotoxin and related compounds. 4. Stereospecific total synthesis of DL-tetrodotoxin. *J.Am.Chem.Soc.*, 94:9219-21
1972
- Kosuge, T. *et al.*, Isolation and structure determination of a new marine toxin from the Japanese ivory shell, *Babylonia japonica*. *Tetrahedron Lett.*, 1972:2545-8
1972
- der Marderosian, A., Marine pharmaceuticals. *J.Pharm.Sci.*, 58:1-33
1969
- Mori, M. *et al.*, The composition and toxicity of wax in the flesh of castor oil fishes. *Nippon Suisan Gakkaishi*, 32:137-45
1966
- _____, Three species of teleost fish having diacyl glyceryl ethers in the muscle as a major lipid. *Nippon Suisan Gakkaishi*, 38:56-63
1972
- Mosher, H.S. *et al.*, Tarichatoxin-tetrodotoxin: a potent neurotoxin. *Science, Wash.*, 144:1100-10
1964
- Narahashi, T., Mechanism of action of tetrodotoxin and saxitoxin on excitable membrane. *Fed.Proc.Fed.Am.Soc. Exp.Biol.*, 31:1124-32
1972
- Nevenzel, J.C. *et al.*, Lipids of some lantern fishes (family Myctophidae). *Comp.Biochem.Physiol.*, 31:25-36
1969
- Noguchi, T. and Y. Hashimoto, Isolation of tetrodotoxin from a goby, *Gobius criniger*. *Toxicon*, 11:305-7
1973
- Noguchi, T., S. Konosu and Y. Hashimoto, Identity of the crab toxin with saxitoxin. *Toxicon*, 7:325-6
1969
- Okaichi, T. and S. Nishio, Identification of ammonia as the toxic principle of red tide of *Noctiluca miliaris*. *Bull.Plankton Soc.Japan*, (23):75-80
1976
- Oshima, Y. *et al.*, Toxins of the *Gonyaulax* sp. and infested bivalves in Owase Bay. *Nippon Suisan Gakkaishi*, 42:851-6
1976
- _____, Heterogeneity of paralytic shellfish poisons. Three new toxins from cultured *Gonyaulax tamarensis* cells, *Mya arenaria* and *Saxidomus giganteus*. *Comp.Biochem.Physiol. (C. Comp. Pharmacol.)* 57:31-4
1977
- Randall, J.E., A review of ciguatera, tropical fish poisoning, with a tentative explanation of its cause. *Bull.Mar.Sci.Gulf Caribb.*, 8:236-7
1958
- Schantz, E.J. *et al.*, The purification and characterization of the poison produced by *Gonyaulax catenella* in axenic culture. *Biochemistry*, 5:1191-5
1966
- _____, The structure of saxitoxin, *J.Am.Chem.Soc.*, 97:1238-9
1975
- Scheuer, P.J., Marine toxins. *Acc.Chem.Res.*, 10:33-9
1977
- Scheuer, P.J. *et al.*, Ciguatoxin: isolation and chemical nature. *Science, Wash.*, 155:1267-8
1967

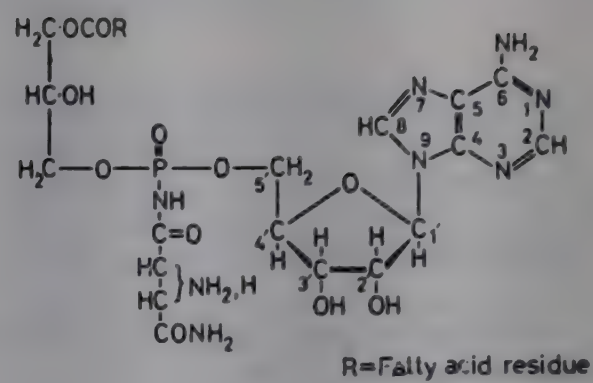
- Schuett, W. and H. Rapoport, Saxitoxin, the paralytic shellfish poison. Degradation to a pyrrolopyrimidine.
1962 *J. Am. Chem. Soc.*, 85:2266-7
- Shibota, M. and Y. Hashimoto, Purification of the ivory shell toxin. *Nippon Suisan Gakkaishi*, 36:115-9
1970
- Shimizu Y., M. Alam and W.E. Fallon, Red tide toxins. In. Food-drugs from the sea proceedings 1974. Edited by
1976 H.H. Webber, and G.D. Ruggieri. Washington, D.C., Marine Technology Society, pp. 238-51
- Shimizu, Y. *et al.*, Presence of four toxins in red tide infested clams and cultured *Gonyaulax tamarensis* cells.
1975 *Biochem. Biophys. Res. Commun.*, 66:731-7
- _____, Structures of gonyautoxin II and III from the east coast toxic dinoflagellate *Gonyaulax tamarensis*.
1976 *J. Am. Chem. Soc.*, 98:5414-6
- Sommer, H. *et al.*, Relation of paralytic shellfish poison to certain plankton organisms of the genus *Gonyaulax*.
1937 *Arch. Pathol.*, 24:537-59
- Tsuda, K., Uber Tetrodotoxin, Giftstoff der Bowfische. *Naturwissenschaften*, 53:171-6
1966
- Wong, J.L., R. Oesterlin and H. Rapoport, The structure of saxitoxin. *J. Am. Chem. Soc.*, 93:7344-5
1971
- Woodward, R.B., The structure of tetrodotoxin. *Pure Appl. Chem.*, 9:49-74
1964
- Worth, G.K., J.L. Maclean and M.J. Price, Paralytic shellfish poisoning in Papua New Guinea, 1972. *Pacif. Sci.*,
1975 29: 1-5
- Yamamoto, T. *et al.*, Studies on poisoning mechanism of ivory shell. 1. Isolation of bacterium producing a suru-
1976 gatoxin-like substance. *Nippon Suisan Gakkaishi*, 42:1405-9
- Yasumoto, T. and K. Kanno, Occurrence of toxins resembling ciguatoxin, scaritoxin and maitotoxin in a turban
1976 shell. *Nippon Suisan Gakkaishi*, 42:1399-404
- Yasumoto, T. and Y. Kotaki, Occurrence of saxitoxin in a green turban shell. *Nippon Suisan Gakkaishi*, 43:
1977 207-11
- Yasumoto, T., R. Bagnis and J.P. Vernoux, Toxicity of the surgeonfishes. Properties of the principal water-
1976 soluble toxin. *Nippon Suisan Gakkaishi*, 42:359-65
- Yasumoto, T. *et al.*, Toxicity of the surgeonfishes. *Nippon Suisan Gakkaishi*, 37:724-34
1971
- _____, Finding of a dinoflagellate as likely culprit of ciguatera. *Nippon Suisan Gakkaishi*, 43:1021-6
1977

Appendix 1

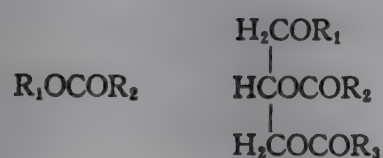
Structural Formulae



Tetrodotoxin

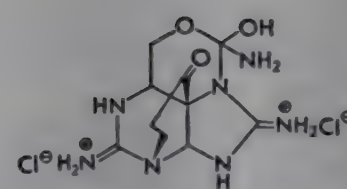


I Dinogunellin

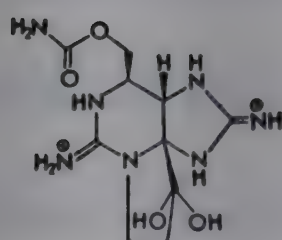


Wax ester

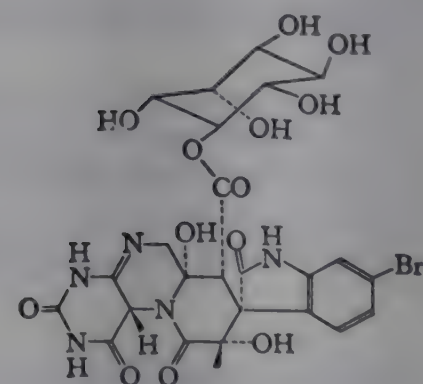
Diacyl glyceryl ether



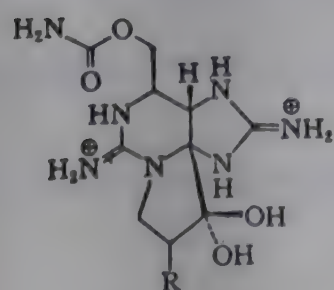
Saxitoxin
(according to Wong *et al.*, 1971)



Saxitoxin
(According to Schantz *et al.*, 1975)



Surugatoxin



Gonyautoxin
R= a-OH, I
R= B-OH, II

POST-HARVEST HANDLING AND MARKETING OF FRESHWATER FISH IN HONG KONG

by

K.W.J. Cheng
Agriculture and Fisheries Department
Hong Kong

Abstract

Live freshwater fish are sold at a premium price; processing and storage are unnecessary but special handling and transport arrangements and a rapid market turnover become essential. Local production supplies only 15 percent of the total freshwater fish consumption; the balance is imported mainly from China. The principal species marketed are grey mullet and the major Chinese carps. Harvesting begins in July but is most intensive at the end of the year. Distribution to the various market outlets is by lorries equipped with tanks, either aerated or with a circulatory water system, to keep the fish alive. The Government, through the Department of Agriculture and Fisheries and other departments, provides a number of market premises with essential facilities and services as required. Marketing requirements are kept under constant review in order to increase productivity on the market floor and to hold handling and transport costs at an acceptable level. Plans are under way to replace the existing freshwater fish wholesale markets by moving them into two multi-purpose market complexes.

INTRODUCTION

The consumer's preference for fresh fish has affected the post-harvest handling of freshwater fish and has led to a direct but specialized distribution system to retail outlets. Processing and storage are unnecessary because of the premium price paid for live fish. Conversely, special handling, transport arrangements and rapid marketing turnover are essential. Imports, which supply 85 percent of the total freshwater fish consumed, play a significant role in the institutional aspects of marketing.

SOURCES OF SUPPLY

It is estimated that there are about 500 pond fish farms in Hong Kong, located mainly in the north-western part of the New Territories, adjacent to Deep Bay. These farms range considerably both in size and number of ponds. Annual yield in 1976 amounted to 5 200 tonnes, representing about 15 percent of the total market supply, the balance being imported mainly from China. The most popular species marketed are grey mullet (*Mugil cephalus*), big-head (*Aristichthys nobilis*), common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys* spp.) and grass carp (*Ctenopharyngodon idella*).

HARVESTING

Grey mullet is stocked from January to March and the Chinese carps from late March to early April. Management is adjusted to take advantage of differences in size and weight. Thus at the beginning of the season it is possible to introduce high stocking densities of grey mullet when the total biomass in the pond is low and the growth rate of other fish species is not affected. Later the grey mullet are thinned out for marketing in July and August. The reduction of fish biomass in mid-summer ensures that the growth of other species is not hampered and, therefore, that the given space is fully utilized.

Harvesting begins in July but is not intensive until the end of the year. Several factors are taken into consideration in deciding when to harvest, the more prominent being weight and prices of fish. The biomass in the pond is also important in order to maximize the growth rate and reduce the likelihood of summer fish kills.

The minimum market size for grey mullet is 100 g which is usually reached in July or August. The Chinese carps are harvested at the end of the season; 100 g for common carp and edible gold fish and 300-400 g for silver carp, big-head and grass carp. Sometimes a number of fish are left unharvested, to be cropped in June and July of the following year.

Harvesting is by cast nets or seine nets. It is labour-intensive but, in the absence of skilled labour, many of the farm operators harvest by themselves. There is inevitably some rough handling, causing mortality during or after harvest. The average yield from well maintained ponds is about 3.5 tonnes per hectare per annum. The percentages of different species harvested from a selected pond are shown in Table 1.

Table 1

A case study of the production value of a 6.8 ha farm^{a/}

Fish species	Quantity of stock (kg/ha)	Percentage of total harvest	Average price HK.\$/kg
Grey mullet	2 455	41.9	10.3
Silver carp	676	11.5	5.0
Big-head	1 012	17.3	7.0
Grass carp	636	10.8	9.0
Common carp	958	16.3	5.5
Edible goldfish	127	2.2	8.15
Total	5 864	100.0	8.15

a/ Though variations exist among farms it is generally representative of the performance of this system of culture

POST HARVEST HANDLING

The fish are held in keep nets in the ponds and then taken alive to the market in lorries equipped with tanks which are either aerated or have a circulating water system. This is economical because of the premium price that live fish command. Grey mullet are difficult to keep alive and are chilled in ice and brine by the farmers before being marketed. The salinity has to be maintained around 1 percent to preserve the natural fish colour.

DISTRIBUTION NETWORK

Unlike marine fish, which can only be sold at one of the seven wholesale markets operated by the Fish Market Organization (a public corporation established under the Marine Fish Marketing Ordinance), there is at present no control over the wholesale marketing of freshwater fish. Marketing of freshwater fish is undertaken mainly by the private sector, with the Government providing only the essential facilities and services which are required to contain marketing costs and to provide for orderly and hygienic marketing.

Local producers send most of their live fish to the wholesalers at Yueng Long, a market town in the New Territories close to the fish pond area. Small quantities are also sent to the Kowloon wholesale markets some 20 mi away. There are 14 importers of freshwater fish, one of whom deals exclusively in imports from China. The other 13 importers deal with other countries. Imports from China arrive live mainly by river boats or by rail; those from other countries normally come by air. Unloading, transportation and distribution are handled by the importers, again in lorries with aerated water tanks to keep the fish alive for sale at the nearest wholesale markets.

There are three major wholesaling outlets for both local and imported freshwater fish. On Hong Kong Island all freshwater fish wholesalers, together with those trading in shrimps and prawns and miscellaneous fresh fishery products (other than marine fish), are accommodated in the Kennedy Town Wholesale Market. This market is provided and maintained by the Government. In Kowloon, a temporary wholesale market is operated by the Agriculture and Fisheries Department at Cheung Sha Wan. At Yueng Long, in the New Territories, a small private wholesale market is operated by a group of dealers on land leased by the Government. Local production is sold largely in the New Territories, imports are sold in the urban areas. Distribution to retail outlets is by lorries with aerated water tanks. There are about 300 retailers in Hong Kong Island, 600 in Kowloon and 100 in New Territories. Each retailer may own one or two stalls in different markets.

The mode of arrival of fish at each of the three freshwater fish wholesale markets in 1976 is estimated and shown in Table 2. A flow chart of the total quantity of freshwater fish marketed in 1976 is given in Figure 1.

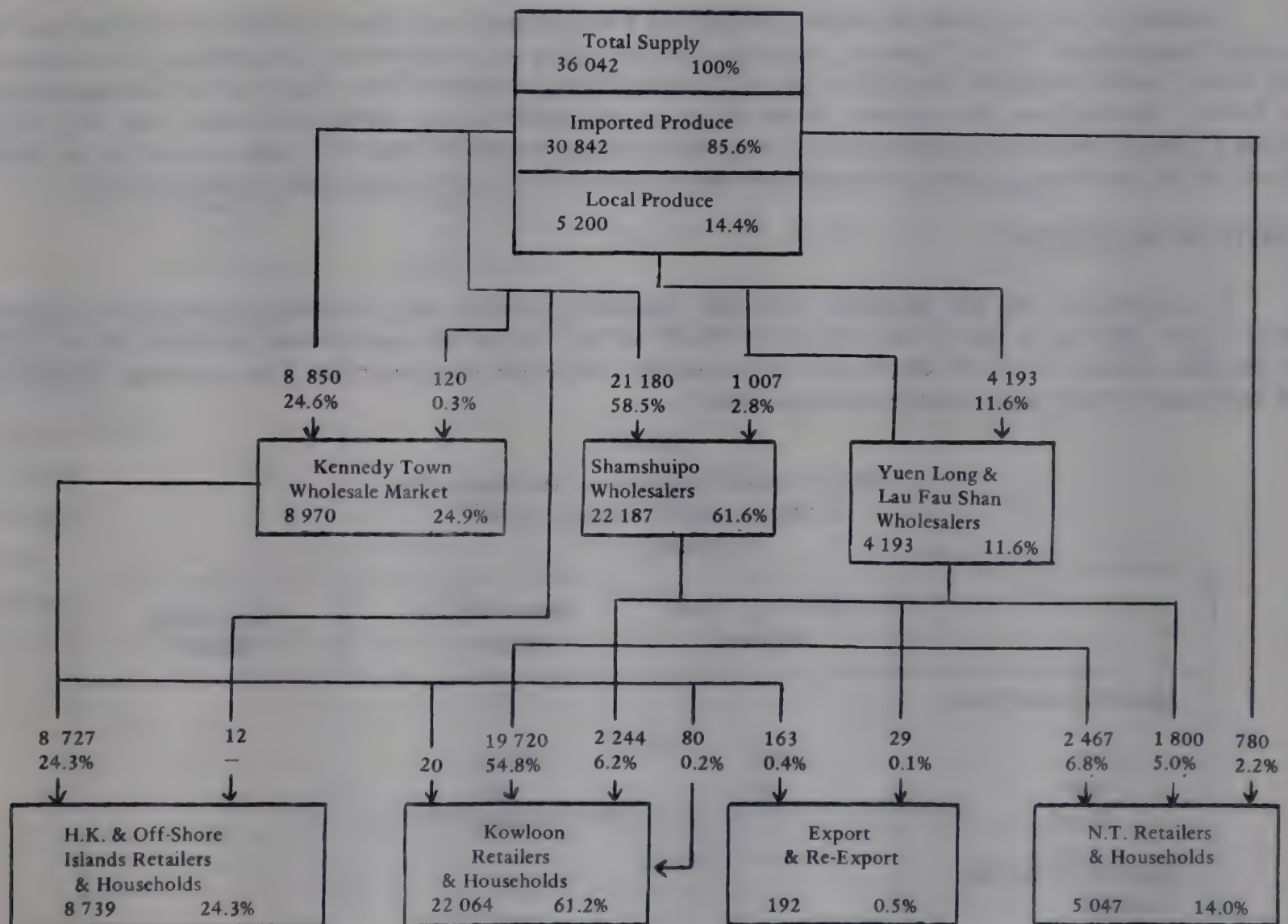


Figure 1 – Flow chart of fresh, chilled and frozen freshwater fish in 1976 (quantity in tonnes)

Source: Agriculture and Fisheries Department, Hong Kong

In general, the wholesale markets are quite accessible to retail outlets in terms of distance. However, distribution to retail outlets may be delayed because of traffic congestion in the dense urban areas, which increases transportation costs per unit of fish distributed. It is estimated that the transport cost from wholesale to retail is about 11 percent of the total market cost. Fish mortality costs amount to 17 percent.

WHOLESALE MARKET OPERATION

In Kennedy Town and Cheung Sha Wan Markets, most sales are negotiated daily between 06.00 and 12.00 by some 600 buyers/retailers. A buyer may be a retailer or an agent-buyer acting for and paid by one or several retailers. In Yueng Long Markets, there are two sale sessions; one between 02.00 and 03.00 h for live fish and the other about 12.00 h for grey mullet. On arrival at the wholesale market, the fish are unloaded into baskets, provided by the wholesalers, and weighed. Live fish are then transferred into water tanks pending sale to buyers/retailers. Grey mullet are chilled and kept in baskets for sale.

Sales are by negotiation. The purchased lots are weighed in baskets provided by the wholesalers or in nylon bags belonging to the buyers. A 'master' beam scale of the buyers' association may be used to settle any dispute over the weight. The purchased produce, after weighing, is moved to outward delivery lorries which are also fitted with water tanks to hold the fish. Fish mortality at the wholesale level is comparatively low. It is estimated that the loss of fish is about 2 percent of the total marketing costs.

Purchase are usually made on credit; A buyer may purchase from more than one wholesaler whose mark-up normally ranges from 18 to 25 percent, depending on the quality and condition of each particular lot of fish and the current market situation. In addition, the wholesalers dealing in imports from China receive a sale commission of 2.5 to 3 percent from the importer. In the case of the wholesaler dealing with local produce, they may charge about 5 percent commission on the sale proceeds from the local farmers in return for loans extended to the latter. These are for pond maintenance or construction, the purchase of feedstuffs and various running expenses.

COSTS OF MARKETING

It is estimated that the marketing costs for imported freshwater fish from the importer (costs incurred after import delivery) to the retailer, amount to HK.\$ 1.60/kg^{1/} of live fish; and for local products HK.\$ 1.73/kg of live fish. Table 3 shows the distribution of marketing costs of live freshwater fish. The percentage breakdown of marketing costs by major items is shown in Table 4.

Table 2
The methods of transport of freshwater fish
at the wholesale markets, 1976^{a/}
(tonnes)

	Kennedy Town Market	Sham Shui Po Market	Yueng Long Market
<i>Imports from China</i>			
Sea	7 692	18 965	—
Rail	78	252	—
Road	—	1 855	—
<i>Imports from other countries</i>			
Air	1 080	108	—
<i>Local yields</i>			
Road	120	1 007	4 073
Total delivery into markets	8 970	22 187	4 073

a/ Excluding a total quantity of 812 tonnes of imports sold directly to the various retail outlets without passing through the wholesale markets

1/ 4K \$1 = U.S. \$ 0.28 (April 1978)

DEMAND AND SUPPLY PROJECTIONS

Ongoing supply and demand projections are kept as part of routine market intelligence services. Although these indicate only trends of supply and demand, the consumption data thus obtained are necessary for making decisions relating to overall food supply and in the development of marketing facilities capable of absorbing increases in trade and distribution efficiency.

Demand projection is based on past trends modified for development factors such as population growth and changes in *per caput* demand due to increased affluence and price changes. Based on time series analysis of *per caput* demand over the period 1961-1976, the income elasticity of demand for freshwater fish is 1.2 33337 and its own price elasticity is -0.68766. The projected *per caput* demand for freshwater fish is 9.58986 kg in 1981, 10.63080 in 1986 and 11.60105 kg in 1991. The estimated total demand for the respective years is given in Table 5.

Table 3

The marketing costs of live freshwater fish (HK. cents)

	Transport (incl. portage)	Containers and equipment	Labour	Rental	Utility and other charges	Mortality
Importer (costs incurred after end of import delivery)	3.97	—	0.1	—	—	—
Producer	9.92	—	4.96	—	—	—
Wholesaler	—	0.43	10.50	0.57	0.42	4.00
Buyer	—	0.10	14.00	—	—	—
Retailer	18.9	2.61	69.00	3.13	3.91	29.00

Table 4

The distribution of marketing costs by items in percentages

Item	Local produce	Imports
Transport	17	14
Containers and equipment	2	2
Labour	57	58
Rental	2	2
Utility and other charges	3	3
Mortality	19	21
Total	100	100

Table 5

The projection of demand for freshwater fish 1981, 1986 and 1991

Year	Medium projection of Population	Estimated <i>per</i> <i>caput</i> demand (kg/year)	Estimated total demand (tonnes)
1981	4 865 500	9.58986	46 659
1986	5 377 400	10.63080	57 166
1991	5 895 500	11.60105	68 394

Because of the heavy reliance on imports, a projection of the total supply of freshwater fish is more difficult. Furthermore, it is not possible to establish any logical bases for estimating imports except by extrapolation from past trends. Assuming a constant ratio of exports and re-exports, the total potential freshwater fish market in 1991 could amount to 67 000 to 70 000 tonnes (i.e., almost double the total market requirement in 1976). Of this, local production could amount to 7 000 tonnes, when all potential pond areas are fully utilized at the present yield rate of 3.2 tonnes per hectare. However, if average yield were to increase, say to 5.0 tonnes per hectare, which is not unlikely by improved management, production could reach more than 10 000 tonnes under the existing constraints.

MARKET DEVELOPMENT FOR THE WHOLESALING OF FRESHWATER FISH

In view of the increasing demand for freshwater fish, attributable to such factors as population growth and increased *per caput* income, there is a continuing need to keep operational procedures under review especially to increase productivity on the market floor and to hold handling and transport costs at an acceptable level.

Following a comprehensive survey of wholesale markets for freshwater fish, crustaceans and miscellaneous fishery products in 1972, measures have been taken by the Government to improve the efficiency of existing markets in the urban areas by rationalizing distribution and market intelligence services. This work falls under the responsibility of the Agriculture and Fisheries Department. Within this Department the Marketing Section is primarily concerned with the planning, development and operation of new wholesale markets and the operation and improvement of existing wholesale markets.

A new temporary wholesale market at Cheung Sha Wan, Kowloon, for freshwater fish will be completed soon. As a result of Government development projects in the Sham Shui Po area, the marketing activities of the freshwater fish trade in the already very congested district would be seriously disrupted. There is an urgent need to provide accommodation for this trade until the proposed multi-purpose permanent market in Kowloon is constructed. Long-term planning for two permanent multi-purpose wholesale markets in the western Reclamation area, in Hong Kong Island and Cheung Sha Wan, Kowloon, is under way. A schedule of the accommodation for these two market complexes has been drafted. They will cater for wholesale traders dealing in vegetables, fruit, poultry, freshwater fish, crustaceans and eggs. The market in the western Reclamation area, Hong Kong, is expected to be completed by 1981 and will consist of a one-storey structure, occupying a land area of some 450 000 ft² (41 805 m²). The total capital cost for this complex has recently been estimated at about HK.\$ 60 million. The market in Cheung Sha Wan, Kowloon, is expected to be completed by 1982 and will consist of a two-storey structure built also on reclaimed land and occupying a land area of some 700 000 ft² (65 030 m²); the total capital cost is estimated to be over HK.\$ 100 million.

A NOTE ON FISH INSPECTION IN THE PHILIPPINES

by

C.D. Balista
Bureau of Fisheries and Aquatic Resources
Manila, Philippines

Abstract

The system used to carry out fish inspection as set out by the Philippine Bureau of Product Standards is described. Details are given of procedures for obtaining export certification.

INTRODUCTION

The quality of fish starts to deteriorate as soon as it leaves the water. Hence, the proper handling of fresh fish is important from the moment of capture until the time it reaches the consumer.

To tackle the problem of keeping fish fresh, quality standards have been established to serve as a guide to producers, distributors and consumers in determining good quality products. The Philippine Bureau of Product Standards with the guidance of the Technical Committee on Fish and Fishery Products has drawn up two Philippine Standards:

1. PTS 031.01, 1969 Standardization of Fresh, Chilled and Frozen Fish;
2. PTS 031.03, 1970 Standardization of Live, Fresh, Chilled and Frozen Shrimp.

PRODUCTION

Fish and fishery products in the Philippines are derived from three main sources:

- (a) Marine fisheries which cover waters more than seven fathoms deep using boats of more than three tons (commercial fishing);
- (b) Fishponds and natural waters;
- (c) Municipal fisheries which operate in all waters under seven fathoms. The boats of three tons or less and fishing gear not requiring the use of boats (subsistence fishing).

The catches are landed at designated points or fish landings located in strategic places throughout the country. This procedure provides more systematic and orderly distribution and marketing of the different kinds of fishery products, and facilitates the inspection of catches, fishing boats, gear and fishermen.

Fish production is increasing annually. The marked increase during the last decade was due to the mechanization of fishing craft, the introduction of new and improved gear and equipment, and the employment of the services of fishery experts.

FISH INSPECTION

Fish inspection is carried out at fishing grounds, aboard fishing boats, at fish landings, fish markets, processing plants and cold storage plants. The main objective of the inspection is to determine whether or not the fish and fishery products were caught by illegal means, such as explosives (dynamite), obnoxious substances (poisons) and fishing by electricity. Quality control of fish and fishery products has been given more emphasis since 1969 when quality standards for fish and shrimp were formulated.

Some measures which help to promote the production of good quality fish are: employing master-fishermen, who are graduates of fishery schools, training skippers, engineers and masterfishermen at the Fishermen's Training Center of the Bureau of Fisheries and Aquatic Resources; giving an incentive or bonus to fishing boats with good quality fish; the establishment of ice and cold storage plants in strategic places in the country. Above all, production of good quality fishery products is largely the result of the educational campaign at all levels and sectors of society and of the research undertaken by different agencies.

Fishery products transported from the origin or source, must be covered by an auxiliary invoice which accompanies the products to their destination. This document indicates such data as shipper, consignee (with addresses), kind of fishery product, container, weight, value, fishery fee and official receipt indicating payment and place and date of issue. It is made under oath and can be secured at the nearest fishery office of the source of the product.

At the destination, a certificate of discharge is made by the fishery officer before release of the product.

EXPORT PROCEDURES AND DOCUMENTATION

The Philippines has exported fish and fishery products since before the second world war. Export procedures and documentation have undergone several changes; with the implementation of the Four-Year Expanded Fish Programme by the Bureau of Fisheries and Aquatic Resources, Fisheries Administrative Order No. 112 was promulgated. This order prescribed the rules and regulations governing the issue of Special Permits to export fish and fishery products. An exporter under this Order has to file an application to export and pay an application fee of P.Ps 5.00^{1/} together with the request for inspection. The Officer-in-Charge of the National Export Coordinating Center (Fisheries), the Regional Director or his authorized representative accepts the documents. He assigns an inspector who will check and register the documents. If the application is in order, the inspector conducts an inspection of the commodity at the place of storage. If the commodity inspected satisfies the requirements, he recommends approval of the inspection report and requires the exporter to pay the permit fee of P Ps 50.00 and inspection fee of 0.5 percent of the declared value. In case of doubt on the quality, the inspector takes samples at random and submits to the Quality control Laboratory of the Bureau for examination. Upon receiving a favourable inspection report from the laboratory, the Special Permit is issued after the payment of the required fees.

In recent years, steps have been taken to reduce the complexity of export procedures, but these procedures are still expensive and time-consuming to exporters and the regulatory agencies. Under Presidential Decree No. 930 the whole system has been greatly simplified. Basic documents (Report on Foreign Sales, Export Declaration, Commodity Clearance and Certificate of Origin) have been aligned with international standards. The Export/Entry form has been eliminated thus reducing the number of documents required. Several steps are now done simultaneously, thus reducing the time spent in export procedures. Commodity clearance and tax clearance can now be issued on a periodic, instead of a per shipment basis, and only one commodity clearance is required; previously, several clearances were required for the same commodity

1/ P.Ps. 1 = US\$ 0.136 (April 1978).

FISH INSPECTION AND QUALITY CONTROL OF FISH EXPORTS FROM THE PHILIPPINES

by

Casimiro D. Balista and Josefina G. Santos
Bureau of Fisheries and Aquatic Resources
Intramuros, Manila, Philippines

Abstract

The development and promotion of exports is an essential step toward the maintenance and stability of the Philippine economy. It is, therefore, imperative that every effort should be made to develop and expand the export trade. To facilitate such an aim, it is necessary to institute a system of quality control to produce consistently safe, wholesome and uniformly high-quality fishery products in order to enhance their marketability, locally and abroad.

The Bureau of Fisheries and Aquatic Resources, in its effort to improve the quality of fishery products for local consumption and export, is collaborating with fish processing establishments to implement the quality control programme appropriate to the nature of the product and processing operation.

This paper describes how to conduct, in accordance with regulations, fish inspection and quality control on fresh, chilled and frozen fish and fishery products. It also describes simplified export procedures and documentation for the exportation of Philippine products.

INTRODUCTION

The nutritional value of fish is well known and to promote its acceptability necessitates the preservation of good quality through quality control. To accomplish this objective, the Bureau of Fisheries and Aquatic Resources of the Department of Natural Resources has set up a Fish Inspection and Quality Control Section to provide the mandatory inspection of fish and fishery products for export, inspection of fish processing plants, and the establishment of cold storage plants.

CREATION OF FISH INSPECTION AND QUALITY CONTROL SECTION

Under Presidential Decree No. 704, the Fish Inspection and Quality Control Section was created under the Utilization Division of the Bureau of Fisheries and Aquatic Resources (BFAR). Its main function is to set up quality standards and to maintain and improve quality standards for the benefit of the fishing industry.

Quality standard for frozen shrimps and tuna have been established under Fisheries Administrative Order No. 117. The standard includes a description of the general appearance, colour, odour, flavour, texture, glaze and other factors. Depending upon their freshness shrimp or tuna are classified into four grades. Quality standards for shrimp and tuna prior to processing, during processing, and the manner of conducting inspection and examination are specified in the standard.

INSPECTION OF FISH AND FISHERY PRODUCTS FOR EXPORT

The Government, realizing the value of quality assurance in terms of protecting and maintaining the good name of the commodity, has provided for, in Presidential Decree Nos. 43 and 704, Fisheries Administrative Order Nos. 112 and 117, the mandatory inspection of fish and fishery products destined for export.

Under Presidential Decree No. 930, which simplified export procedures, the Bureau of Fisheries and Aquatic Resources has jurisdiction over the following fish products and issues a commodity clearance prior to export.

1. Crustaceans (shrimps, lobster, prawns, crabs: (live, fresh, chilled and/or frozen)
2. Fish (live, fresh, chilled and/or frozen)
3. Fish by-products (liver oil, shark teeth, pearl essence, fish meal, etc.)
4. Molluscs (clams, oysters, mussels, scallops, snails and other shellfish: live, fresh, chilled and/or frozen)
5. Pearl
6. Raw shells and shell meat
7. Reptile skins
8. Sea cucumber
9. Seaweeds and their by-products
10. Sponges

Processed fish and fishery products such as canned tuna, fish sauce, etc. fall under the jurisdiction of the Food and Drug Administration. However, the Bureau of Fisheries and Aquatic Resources has jurisdiction over the processing plants to check on the quality of the raw material and hygienic conditions of the plants. The BFAR has regional offices all over the country and at main exports outlets, there are fish quality inspectors who are authorized to inspect fish and fishery products destined for export.

A prospective exporter files an application to export with the office of the BFAR. An inspector is assigned to inspect the product at the place of storage. If the products tally with the export declaration, the inspector proceeds with a systematic organoleptic examination of the fish products. The glazing, net weight and packaging are also checked. If the product conforms to quality standards, a certificate of inspection is given and a special permit to export is issued after payment of the fees due.

In cases of doubt about the quality of the product, the inspector can submit samples to the Fish Inspection and Quality Control Laboratory of the BFAR for further tests and confirmation of findings. At the laboratory a taste panel, and chemical and bacteriological examinations are conducted. The chemical tests are made to determine the trimethylamine (TMA) and total volatile bases (TVB). The inspection report reflects the quantity which is allowed for export.

For products found to be of poor quality, the exporter is duly advised by the fish inspector on the method of disposal of the product. It may be sold locally for domestic consumption or it may be processed to some other form such as fish meal. Exporters are also instructed on handling and processing techniques to be able to comply with quality standards.

INSPECTION OF FISH PROCESSING ESTABLISHMENTS

In September 1975 the Bureau of Fisheries and Aquatic Resources introduced Fisheries Administrative Order No. 117 which covers the inspection of fish processing plants. The law provides that no one may operate a fish processing plant unless he complies with the minimum requirements, provided that existing processing plants are given a period of two years from the effective date of the order to comply with the requirements. The purpose of this order is to ensure that fish and fishery products are processed under ideal sanitary and hygienic conditions. There are specification requirements on the plant and equipment, the procedures to be followed in freezing and cold storage, production requirements, personnel and premises.

ESTABLISHMENT OF COLD STORAGE PLANTS

The BFAR has established several cold storage plants, strategically located at fish landings, in order to preserve the good quality of the catch until it reaches the consumer. The use of cold stores helps to equalize the supply and demand for fish, the excess catch that cannot be disposed of can be stored and used when there is a demand. This helps to stabilize the price of fish and promote fish consumption.

FISH CONSUMPTION TRENDS IN INDIA

by

K.K. Balachandran, P.A. Perigreen and M.R. Nair
Central Institute of Fisheries TEchnology
Cochin, India

Abstract

Over the past two decades, India has witnessed a tremendous expansion of the fish processing industry, the produce being destined only for export. Fresh fish is still the principal means of disposal of the fish catch for human consumption while traditionally cured fish has been the main processed product available to the local population. Statistics on disposal of the fish catch show a marginally decreasing proportion consumed as fresh fish. With the availability of improved technology in various fields of processing; this share is bound to decrease further, being replaced by fish processed in various ways.

INTRODUCTION

Before the advent of modern methods of preservation such as freezing and canning, the only method of preserving fish in India was curing. Processing was organized on a cottage scale and there was a flourishing export trade with neighbouring countries such as Burma, Sri Lanka, Hong Kong, etc. However, by the end of the second world war this industry faced a serious setback when the traditional buyers abruptly stopped their purchases. Subsequently, a regeneration of the fish processing industry occurred and modern methods of preservation were adopted. A shift in the market from the east to the west also occurred. India entered the export trade in processed fishery products in a modest way over two decades ago and today it is one of the major suppliers of processed fishery products in the world markets, netting a return in foreign exchange of I.Rs. 1 800^{1/} million in 1976. Of this total, 76.5 percent in terms of quantity and 89.5 percent in terms of value was contributed by frozen and canned prawns although the relative share of canned prawns is small.

Irrespective of the significant developments in processing methods throughout the world, fresh fish still remains the principal mode of disposition of world fish catches although a marginally decreasing share can be observed from 1973 onward (Table 1).

Table 1

Disposition of world fish catch

	1973	1974	1975
Total landing (million t)	66.8	70.5	69.7
Marketing fresh (% of total)	30.69	30.21	28.7
Freezing "	18.71	18.29	18.22
Curing "	12.12	11.45	11.62
Canning "	10.62	10.21	10.33
Reduction "	26.34	28.37	28.69
Miscellaneous purposes "	1.47	1.42	1.43

Source: Yearbook of Fishery Statistics, 1975, FAO, Rome

^{1/} I.R.s 1 = U.S.\$ 0.119 (April 1978)

Fish utilization

Whereas frozen and canned fish together made up the bulk of the disposition of world fish catch, curing is still the principal method of preservation in India (Table 2).

Table 2

Disposition of fish catch in India

	1972	1973	1974	1975
Total landing (thousand t)	1 640.2	1 958.0	2 255.3	2 328.0
Marketing fresh (% of total)	68.74	65.3	63.7	69.43
Freezing "	5.01	5.53	4.48	2.80
Curing (sun-dried) "	17.43	19.39	23.23	18.96
Canning "	0.58	0.81	0.44	0.21
Reduction "	4.98	5.33	4.94	6.09
Miscellaneous purposes	3.24	3.67	3.17	2.58

Source: Yearbook of Fishery Statistics, 1975, FAO, Rome

At the end of 1975 the total capacity available for freezing fish was 1 000 tonnes per day. The export of frozen fishery products, including froglegs, in 1976 was only 53 863 tonnes; thus there is considerable idle capacity for freezing. In the early sixties there was a rapid development in prawn canning in India; this almost collapsed ten years later. Export of canned prawns reached a peak of 2 578 tonnes (worth I.Rs. 39.5 million); this fell to 102.4 tonnes (valued at I.Rs. 3.9 million) in 1976. Total export of canned fishery products in 1976, including prawn, crab meat, sardine and other fish was 170.8 tonnes (worth I.Rs. 5.94 million) which implies that most of the installed capacity for canning was also lying idle.

Despite the idle capacity in the freezing and canning sectors, the principal form of processed fish which is available for the local population is dried fish, processed according to age-old methods. Since the modern fish processing industry was developed solely for export, no attention was paid to the development of internal markets for such products, nor was the technological know-how available other than for prawns. Compared with this the provision of infrastructure and transportation for fresh fish was relatively rapid. The provision of motorable roads connecting the landing sites with markets, the use of improved transport, the establishment of ice factories near the landing sites, etc. and the application of research work carried out in different research laboratories in the country together resulted in fresh fish being made available to consumers living thousands of miles away from the landing places.

However, the rapid rate of industrialization and increased urbanization are likely to cause a change in the fish-eating habits of the population; consumers may demand an increased proportion of processed fish. A readjustment of the modern fish processing industry, to cater for the internal demands, therefore deserves consideration. Moreover, a well-developed internal market for frozen and canned fish can provide a buffer for the industry in case the export trade suffers a set-back. However, such considerations should always keep in mind a low-cost formula and product approach so that the products come within the purchasing capacity of the population. Another important requirement for popularizing processed fishery products within the country should be a vigorous sales promotion and extension campaign.

Freezing

A number of small cold stores, most of which have small cabinet deep freezers, are now found in all the major towns and cities of India for the sale of fresh/frozen fish. Since ample freezing capacity is already available, provision of additional stores and a fleet of refrigerated vans would provide the necessary infrastructure for the sale of frozen fish products. The technology for quick freezing and cold storage of fish, particularly those available in large quantities, viz. sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*), catfish (*Tachysurus* spp.), seer (*Scomberomorus guttatus*), etc., has been developed in the Central Institute of Fisheries Technology. Methods of freezing these fish, whole, in blocks or otherwise, have been developed and the prevention of quality loss during storage has also been studied. The Integrated Fisheries Project, Cochin, is actively promoting whole frozen fish, slices, fillets and minced meat with promising results.

A more attractive form for retailing frozen fish, particularly the larger fish such as seer will be in the form of boneless and skinless fillets, chunks or slices. Hand-filleting has been found to be an economic proposition. Methods of filleting, packing in consumer packs, freezing and cold storage characteristics of fillets so prepared, etc., have been studied in detail. Picked meat recovered from filleting waste can also be utilized. Table 3 gives the yield of skinless fillets from whole fish and the recovery of picked meat from filleting waste.

Table 3

Yield of skinless fillets from whole fish and recovery of picked meat from filleting waste

Fish species	Size grade (g)	% of skinless fillets	Picked meat from filleting waste as % of filleting waste
1. Catfish (<i>Tachysurus jella</i>)	300–425	24–26	11.9–12.8
2. Indian halibut (<i>Psettodes erumei</i>)	900–1 000	37–40	12–13
3. Seerfish (<i>Scomberomorus guttatus</i>)	3 500–4 200	45–48	11–13
4. Threadfin bream (<i>Nemipterus japonicus</i>)	160–175	25–28	10–11.5
5. Leopard coral trout (<i>Plectropomus leopardus</i>)	2 400–2 650	32–34	8.3–9.0

Canning

Canned fish is a fairly expensive product owing to the high cost of the container and may have a limited impact on local sales unless the costs of production can be reduced substantially. In this context the natural pack sardine, a process developed at the Central Institute of Fisheries Technology for canning sardine in its own juice, can be considered an item worthy of exploitation. There are several unexploited commodities such as clams, mussels, oysters, catfish, etc., which could be canned for sale to the urban population. However, the future prospects will depend on reducing the cost of production by using cheaper containers in place of the costly tin plate cans. Canning fish in bulk quantities should also be explored.

Drying

Sun-dried and salt-cured fish still find a ready market particularly among the low-income groups of the rural population. Considering the future potential for dried fish several attempts have been made to modernize the process, by employing more hygienic practices and by using artificial driers. Different types of driers have been designed and necessary data have been collected. A commercial model drier of one tonne capacity has been designed; two have been installed in the country and are in commercial production. Although the cost of production will be around 50 percent higher than the conventional process, fish dried in mechanical driers will be of better quality and should be readily accepted by urban consumers. The Integrated Fisheries Project, which runs one such drier on a commercial scale, leads the campaign to popularize mechanically dried fish, and has had considerable success.

The possibility of making use of a solar drier, which can substantially reduce the cost of production, is also being investigated

Utilization of miscellaneous fish

Technological research, aimed at better utilization of the low priced miscellaneous fish which are landed along with prawns, is being carried out intensively in different laboratories. Several new products and formulations incorporating fish, fish protein concentrate, fish powder or hydrolyzed fish have been reported; many of these are at different stages of experimentation and commercial exploitation. The products are intended solely for domestic consumption.

If steps are taken to modify the processing industry and the results of technological research are applied, the pattern of fish consumption in India will change and the proportion of processed products will increase.

MARKETING OF FRESH MARINE FISH IN HONG KONG

by

K.W. Chan and N.K. Lee
Agriculture and Fisheries Department
Hong Kong

Abstract

Marine fish is one of Hong Kong's most important primary products. The fishing fleet, consisting of 5 500 vessels, catches 92 percent of all fresh marine fish consumed and more than 150 species of commercial importance are caught. The majority of the demand remains in favour of fresh fish rather than frozen or other processed forms.

The wholesale marketing of marine fish is controlled by the Marine Fish (Marketing) Ordinance of the Laws of Hong Kong which prescribes that all marine fish must be sold through one of the seven wholesale fish markets operated by the Fish Marketing Organization. The Organization is a statutory corporation established under the said Ordinance and administered by the Director of Marketing (Director of Agriculture and Fisheries). It also provides processing and storage facilities for the industry.

Fish is classified as a restricted food under the Food Business By-Laws. The major outlets are confined to stalls in the public retail markets and to fresh provision shops. The management of public retail markets is the responsibility of the Urban Council and the Urban Services Department, whereas fresh provision shops are licensed by the Urban Council. Other less important retail channels are the supermarkets and hawkers. Retail outlets for fish are inadequate, the ratio of household to outlet being much higher than the planning standard. There is a need to improve retail facilities.

The marketing cost from producers/fishermen to consumers, which includes handling, wholesaling, transport and retailing services, is about 9.5 percent of the average retail price.

INTRODUCTION

Marine fish is one of Hong Kong's most important primary products and the bulk of the domestic requirement is caught by local fishermen. Although less than 2 percent of the working population is involved in fishing, the local fishing fleet, consisting of 5 500 vessels, is able to supply some 92 percent of all fresh marine fish eaten in the territory. Domestic demand at present favours fresh rather than frozen or other processed forms of fish, but it is possible that the future consumption pattern will show a gradual increase in processed fishery products. Table 1 shows the supply situation of fresh marine fish in Hong Kong from 1971 to 1976.

MARKET DEMAND

In 1976, the population of Hong Kong was 4.44 million, an increase of 9.8 percent compared with the population in 1971. According to the latest estimates, the real *per caput* GDP, which was HK.\$ 3 610 (U.S.\$ 768) in 1971, has been growing at an average rate of 8.6 percent to HK.\$ 5 170 (U.S.\$ 1 100) in 1976. The total net supply of marine fish, however, increased by only 6.6 percent over the same period; thus, *per caput* consumption changed little (22.96 kg in 1971 and 22.27 kg in 1976). The present slow growth rate of supply in terms of total catch shows that the major marine resource which is at present exploited, namely the demersal fishery, has almost reached its economic sustainable yield. Based on the long-term projections of supply and demand, the estimated per caput consumption of marine fish will increase to 25.6 kg and 28.1 kg in 1981 and 1991, respectively, representing an estimated total demand of 124 500 and 165 400 tonnes. Future demand at this level calls for an increase in production by the development of new demersal grounds or an expanded pelagic fishery, and the planning and development of necessary marketing facilities.

Table 1

Supply situation of fresh marine fish, 1971-76
(tonnes)

Year	Local production	Imports	Exports	Re-exports	Total net supply	Local production as percent of total net supply
1971	86 206	7 452	578	220	92 860	92.2
1972	91 484	7 426	671	318	97 921	92.7
1973	88 004	11 490	2 283	2 196	95 015	90.2
1974	95 071	9 787	1 524	1 286	102 048	91.7
1975	94 904	9 809	3 350	1 541	99 822	91.7
1976	96 847	9 254	5 420	1 734	98 947	92.4

WHOLESALE SYSTEM

The wholesale marketing of marine fish is the primary responsibility of the Fish Marketing Organization (FMO), which is administered by the Agriculture and Fisheries Department. The Organization, established by authority of the Marine Fish (Marketing) Ordinance of the Laws of Hong Kong, is a statutory corporation vested in the Director of Marketing (Director of Agriculture and Fisheries) and its primary functions are to establish, manage and operate wholesale fish markets and other ancillary establishments. The Ordinance provides for the control of the landing, wholesale marketing, importing and exporting of marine fish. In essence, the legislation prescribes that the wholesale marketing of marine fish must be conducted in FMO fish markets and that marine fish may not be transported within the territory of Hong Kong except in accordance with a permit issued by the Director of Marketing. The definition of 'marine fish' in the Ordinance specifically excludes all crustaceans, molluscs and live fish. The FMO operates seven wholesale fish markets, strategically sited for the convenience of the fish buyers and fishing fleet. The services provided at each of these wholesale markets include: unloading, sorting, weighing, sales, deliveries to retail outlets and documentation. The main source of revenue for the Organization is a 6 percent commission on the proceeds of market sales.

Fishermen land their catch, on ice, directly at any of the seven wholesale markets, where the FMO provides labour and mechanized off-loading facilities. Fish species in Hong Kong are numerous and, on arrival at a market, the fish are normally sorted before weighing and subsequent sale. Fish are rarely sorted at sea although the FMO has, for some time, actively encouraged fishermen to do so, since the time involved in sorting at the market is quite considerable. An area of the market is specially set aside and enclosed for this purpose and is under close supervision by the FMO, irrespective of whether the sorters are fishermen, buyers or staff employed by the Organization. The fish are sorted into heavy-duty plastic containers which are provided for the FMO. Each container constitutes a 'lot' of sorted fish for sale.

Prior to sale, each lot is weighed and the seller is given a receipt. This receipt has a lot number which must be produced when he collects the proceeds of the sale. A sales voucher is also made out at weighing for each lot. Then the lots are laid out on the sales floor in the sequence in which they were weighed. Sale is usually by auction conducted by an Auctioneer of the FMO. The highest bidder indicates his acceptance of the sale by stamping his copy of the sales voucher. This is held by the auction clerk who also inserts the unit price of the fish sold on the voucher. A copy of the sales voucher, which also includes transport, is then given to the buyer.

On completion of a sale, the buyer transfers his fish from the Organization's container to his own basket or fish tub. Transport to the buyer's place of business is provided by the FMO for markets in the urban areas.

However, as many buyers are also retailers, they are anxious to leave the market early and often find it more convenient to use their own vehicles or hired lorries. As Hong Kong is small, delivery of fish to the retail markets is relatively short and the fresh/chilled fish reaches the consumer within a few hours of being unloaded.

The completed sales vouchers are the basis for debiting buyers' accounts and paying sellers. Prior to a seller receiving payment, however, the vouchers are passed to the market credit section. At this section, deductions are made from proceeds of the sale for loan repayments, cooperative society dues, etc., and a receipt is made out for each deduction. The seller thus receives the proceeds of sale less any deductions, but is given receipts for the various deductions in addition to a copy of each voucher together with a summary showing the number of vouchers involved, the gross value market commission and the net proceeds of the sale. On payment of their purchases, buyers also receive a copy of the voucher. Copy of the voucher is retained by the FMO for accounting and statistical purposes. On completion of daily transactions at all wholesale fish markets, market accounts are verified and closed. A record of transactions is forwarded daily to the FMO's central Accounts Section for endorsement.

Fish buyers who wish to buy in the wholesale markets are required to register with the FMO. On registration, each buyer is issued an individual stamp which is used to endorse the sales voucher on completion of a transaction. He is registered to purchase at one specific market. Although buyers are generally retailers, exporters and fish processors are also registered to purchase fish. There are some 2,200 registered fish buyers, about half of whom are actively engaged in daily transactions at the wholesale markets. Purchases are made against a deposit made with the FMO, and a credit balance is maintained by buyers who clear their debit notes daily.

RETAILING SYSTEMS

Retail marketing of fish (and other fresh food commodities) is controlled by the Urban Council and the Urban Services Department of the Hong Kong Government. Fish and meat are restricted foods in terms of the Food Business By-Laws under the Public Health and Urban Services Ordinance, Chapter 132 of the Laws of Hong Kong. Fish are retailed through the following outlets: public retail markets, fresh provision shops, supermarkets and by hawkers.

Public retail markets, to accommodate fish, poultry and meat stalls and mini stalls for fruits and vegetables, are built from public funds. There are 41 public retail markets in the urban areas under the control of the Urban Services Department. These markets provide a total of 1,200 retail outlets for fish; about 40 percent have refrigerators.

In addition to public retail markets, there are some 5,300 fresh provision shops licensed by the Urban Services Department. These shops are accommodated mainly in tenement buildings in residential areas and provide a total of 1,850 fish retail outlets.

Two decades ago there were only six supermarkets selling frozen and canned foods in Hong Kong; 90 percent of the customers were expatriates from Europe and other areas. By the end of 1976, the number of supermarkets had risen to 94 (mostly developed in the 1970s) and the clientele was 90 percent Chinese. However, as they are selling mainly packaged and processed foods, supermarkets are so far relatively unimportant retail outlets for fresh fish.

As mentioned above, fresh fish is classified as a restricted food and retail sales are confined in market stalls, fresh provision shops and supermarkets. In practice, however, a certain amount of fresh marine fish is sold by street traders at, for example, fishing ports, where fisherfolk of small vessels come ashore to sell a small catch, or in areas where there is a shortage of legal retail outlets. The total amount thus handled is not significant.

COSTS OF MARKETING

For an average species costing HK.\$ 8.5/kg (U.S.\$1.81/kg) at retail markets, marketing costs from producers to final consumers amount to HK.\$ 0.8/kg (U.S.\$ 0.17/kg), or about 9.5 percent of the average retail price. Marketing services along the normal distribution network include: fishermen's agent, wholesale marketing facilities, and costs for the fish buyers, many of whom are retailers. The 6 percent commission deducted from the gross wholesale value of fish constitutes the major source of revenue for the FMO. In return, the various wholesale facilities and services provided by the Organization have been described earlier. It should be noted that the FMO is operated on a non-profit basis. Surplus funds are ploughed back into the industry mainly in the form of improved marketing facilities, cheap credit to fishermen, and education for fishermen's children.

Fishermen's agent

An agent has an obligation to the fisherman, whom he represents, to sell at the best price. For this and other services, an agent generally charges 2 percent of the gross wholesale value of fish. This commission also covers the possible loss due to the difference between the fisherman's reserve price, which may attract no buyers, and the subsequent sale at a reduced price.

Fish buyer/retailer

Most of the fish buyers at the wholesale markets are retailers themselves, operating one or two fish stalls in the retail outlets. The retailer has first to attract the customer and then to sell the highly perishable stock as quickly as possible. This means keeping prices in line with those of competitors, and of competing foodstuffs, and maintaining as much stability as possible in the pricing (and quality) of particular species. Within these constraints, he must aim to make an adequate net profit. It is estimated that the average retail mark-up for fresh marine fish is about 35 percent above that of the wholesale value. Given this gross margin, the retailer has expenses for transport, labour, rent, water and power, packing materials and other equipment. Figure 1 shows the distribution network for fresh marine fish with estimated costs of marketing at the different levels of distribution.

	Receipt/Payments	Marketing Costs
<i>Fishermen's Receipts</i> (net proceeds)	5.79	
<i>Fishermen's Agents' Receipts</i> (2% of the gross wholesale value of fish)	0.13	(0.13)
<i>FMO Wholesale Markets Receipts</i> (6% of the gross wholesale value of fish)	0.38	(0.38)
<i>Registered Buyers' Payments</i> (wholesale value of fish)	6.30	
<i>Buyer/Retailer Receipts</i> (gross margin) (plus 35% mark-up)	2.20	
(less retailing costs)		
transport		(0.02)
labour		(0.12)

rent			(0.09)
water and power			(0.02)
packing materials and other equipment			(0.04)
	-----	Total Marketing	-----
<i>Consumer payments</i>	0.85	<i>Costs</i>	0.80
(retail value of fish)			

Figure 1 Distribution network for fresh marine fish and estimated marketing costs (HK.\$/kg).

MARKETING DEVELOPMENTS

Wholesale facilities for the marketing of marine fish are adequate. However, in view of town planning requirements, some of the existing markets will have to be reprovisioned and working plans are accordingly drafted to cope with the projected increased volume of throughput. In some of these wholesale markets provision is also made to include facilities to meet future demands, such as fish processing and the handling of both capture and culture marine fish in live condition. Action has been taken to build a new market in a high density area to close the time-distance gap between the existing wholesale markets and retail outlets. Operational procedures within the wholesale markets are under constant review with a view to achieving increased efficiency at lowest possible cost.

A number of public retail markets are old and too small, half of them being pre-war buildings; they are incapable of meeting present and future requirements. This results in undesirable street-trading on the peripheral areas of most of these markets. There is therefore an obvious need for quick action to improve the retail system by redevelopment of old markets in built-up areas and the construction of new ones in the new town areas. The Urban Council and Urban Services Department have drawn up development plans. For the retail marketing of fish, the planning standard is 9.5 fish stalls per 10 000-30 000 persons, depending on long-term land requirements for retail markets and the point at which a market should be built.

ACCEPTABILITY OF MALAYSIAN FISHERY PRODUCTS

by

Asiah M. Zain
Universiti Pertanian Malaysia
Serdang
Selangor, Malaysia

Abstract

Malaysian fishery products are underutilized; they are considered to be poor man's food and are discriminated against by the upper strata of Malaysian consumers.

The fishery products which are commonly consumed are dried and salted fish, 'ikan bilis' (dried anchovies), 'kerupuk' (fish crackers) and 'belacan' (shrimp paste) which are processed at the cottage industry level. They are easy to prepare, have a high protein content, are tasty and are inexpensive in terms of their protein content. Their consumption however is limited to regional and home levels. Reputable eating places do not serve dishes prepared from traditional fishery products. Malaysians in general shy away from serving these products to guests in their home.

Lack of consumer acceptability of these products may be attributed to physical appearance, improper packaging, inadequate quality control, attitudes of the consumer, and insufficient knowledge of local recipes. These factors are discussed at length. Recommendations to improve the acceptability of these products and to promote their consumption are put forward.

INTRODUCTION

Malaysia depends largely on seafoods for its animal protein supply. Rice, being the staple diet, is generally accompanied by fish and fishery products. The increasing price of fish and the short supply of certain kinds of fish in the local markets are signs of a bleak future for the consumer. Unless positive and immediate steps are taken to ensure a stable supply of fish, the industry will face the problem of depletion and overexploitation within the 12 mi coastal zone (Ministry of Agriculture, 1977).

Fish are consumed either fresh or processed. Processed products, however, though highly nutritious, are underutilized; they fail to attract the attention of the majority of Malaysian consumers. Generally, the local fishery products are considered as 'poor man's food', and seldom have the prestige of being served in reputable restaurants or to guests at home. What is wrong with our traditional fishery products?

The main objective of this paper is to consider the acceptability of local fishery products and the problems associated with their low consumption. Suggestions will be made to encourage the processors to improve their products, and to facilitate the better utilization of local fishery products by consumers of every income group.

LOCAL PRODUCTS

Sun-drying, salting and fermentation are the most common methods of fish preservation in Malaysia. There are efficient and low-cost methods; their limitations are the availability of raw materials and a market demand for the finished products. The common products are listed in Table 1.

Methods of processing for some of these products have been discussed elsewhere (Idrus, 1977; Ismail, 1977a,b). Most of these products are regional and are identified with specific localities. Dried anchovies, dried salted fish, dried cuttlefish, 'kerupuk', 'belacan' and canned fish, however, are familiar to most people but their consumer acceptance is poor. Unlike soy sauce, which is widely used in the Far East and is gaining popularity in the U.K. and U.S.A. (Ismail, 1977a,b), Malaysian fishery products are discriminated against generally. A number of factors contribute to the present low acceptability of local fishery products; the following are thought to be important: (1) physical appearance; (2) improper packaging; (3) inadequate quality control; (4) attitudes of the consumer; and (5) insufficient knowledge of local recipes.

Table 1

Fishery products of Malaysia

Dried and salted products	Fermented products	Other products
Dried salted fish of different varieties	'Belacan' (shrimp paste)	Fish sausages
'Ikan bilis' (dried anchovies)	'Budu' (Fish sauce)	Fish bails
Dried salted shrimp	'Cincalok' (shrimp sauce)	Fish cakes
Dried cuttlefish	'Patis' or 'Otak udang' (viscous shrimp sauce)	Canned products such as fish in tomato sauce (sardine,) prawns in chilli sauce, fish in curry
'Kerupuk' (crackers and crisps)	'Pekasam' (fermented fish)	'Serunding' (spicy fish flakes)

Physical appearance of fishery products

With foods, appearance is an important factor for consumer selection. The well known saying that food is not food until it is eaten indicates that food is meant to be consumed, failing which it will constitute a waste. Food will be left untouched and finally discarded if the appearance is not attractive to the consumers.

The appearance of our local fishery products needs improvement. 'Patis', 'budu', 'belacan' and 'cincalok' have a very dull dark colour and this dull appearance does not stimulate the consumer to purchase these products at first sight. Attempts have been made to improve the appearance by putting colour additives into belacan, kerupuk and cincalok. Rhodamine B (non prohibited) was used by some belacan processors to give an attractive pink colour to their products but this was questioned by the consumer association and, as a result, the use of this dye has been banned.

The use of colour additives at the cottage industry level is left entirely to the discretion of the non-professional processors. There is no control over the amount and the type used and, as a result, there is no uniformity in the finished products.

Improper packaging

Liquid products such as budu (fish sauce) and cinalok (shrimp sauce) are sold in bottles meant for soft drinks. It is common to see bottles of different sizes and shapes containing these products displayed in the shops. There is no product identity in terms of the container and its label. Patis, a viscous product (viscous shrimp sauce) is sold in wide-mouth bottles or in cigarette cans.

Belacan which has a cheese-like texture, is packed in baskets and sold in pieces. The belacan industry, however, has made progress in packaging as compared to other cottage industries dealing with fishery products. Processors in the northern part of Malaysia now pack their products in plastic wrappers which are sealed and placed in packets. The product looks hygienic, is easy to handle and its distinct aroma is not exposed. This improved packaging partly contributes to the increasing use of belacan.

Dried salted fish are displayed unpackaged in the shops. At sale they are weighed and wrapped in used newspapers; even products with maggots seem to be acceptable. The moisture content for most dried salted fish is high, resulting in spoilage during storage. A moisture content of 25-50 percent is found in a variety of fish (Hanousek, 1970), but there is no standard for moisture content in dried salted fish. By selling products with a high moisture content a better profit is obtained. The drying process may however, continue in the shop in the upper layers which are exposed; the bottom layers usually show mould growth and/or putrefaction. Even at home the consumers frequently have to dry the product to avoid spoilage.

Kerupuk (crackers) of various sizes, shapes, colour, and made from different kinds of fish are sold in plastic bags with little or no labelling at all.

Inadequate quality control

The need for quality control practices in the production of fishery products at the cottage industry level is very acute. The cleanliness of the utensils, the working conditions and personal hygiene are entirely at the mercy of the processors.

The preparation of kerupuk and budu is carried out in the open air; the raw materials and ingredients are left exposed to flies and dust. The amount of each ingredient used is not standardized and the more business-minded processors use less fish and more of the other ingredients, such as starch, in the making of kerupuk. The finished product is sold at the same price irrespective of its origin and quality. Product uniformity is difficult to achieve since there is no standard method of processing. The products vary widely in their composition, consistency, colour, flavour and shape. Since most of these products do not face competition, the processors do not feel the urgency to improve the quality of the products. Support for the establishment of food quality control programmes by the small and intermediate factories is not very encouraging for economic reasons (Merican, 1976).

Attitudes of the consumer

Most of the local fishery products are characteristic of a particular area. It is believed that urban migration, to some extent, has an impact on the consumption pattern and food habits.

Consumers, in general, consider the traditional products as poor man's food, probably because most of them are cheap. Hence, they are reluctant to serve dishes prepared from these products and prefer to serve their guests with more expensive foods prepared from meat, chicken, egg, fresh fish or shellfish. The consumption of local traditional products is restricted to home use for the family. Customers at middle-class eating places generally feel embarrassed to ask for traditional dishes like 'sambal belacan' or 'ikan bilis', even though these are delicious. Consumers belonging to higher social strata usually do not include traditional dishes in their menu for local dinner parties.

However, two products (ikan bilis and belacan) are slowly gaining recognition. Ikan bilis, fried and made into titbits is available in some refreshment places and 'sambal' (pounded chilli sauce) of varying degrees of hotness is frequently served in restaurants. The recent availability of these dishes in public eating places may be attributed to the increasing price of ikan bilis, which suggests that it is not a low-class food; the packaging and appearance may have contributed to its acceptance.

Generally the Malaysian consumer is not very critical of purchased products; if a product is not up to the level of a housewife's expectation, she would show her dissatisfaction only by buying the same product at a different shop. Another alternative would be to accept the product at a cheaper price. It is doubtful whether Malaysian consumers know their basic rights, that is, a right to be informed, a right to consumer education, a right to compensation against damages, a right to choose and a right to be heard.

Insufficient knowledge of local recipes

One of the reasons for the underutilization of local fishery products is perhaps the lack of knowledge on how to use them. Recipes for using these products in various ways are not available. Although most of the local magazines and newspapers have a regular column for recipes, local fishery products are not featured.

In addition to frying, which is the most common method of cooking, ikan bilis can be included in chilli sauce, cooked with vegetables, roasted and pounded into a powder for babies, roasted with peanuts as titbits or boiled as a soup base. Apart from the use of budu, patis and cinalok as instant sauce or gravy, no other recipes are available.

Formulation of recipes is necessary for the wider use of these products. This does not necessarily involve the creation of new dishes; the products could be included in existing local dishes. Different methods of cooking, such as frying, steaming, boiling, stewing and grilling, with additions of other ingredients, should be tried to give variety in taste and appearance. Recipes should be formulated, tested and distributed to the general public.

RECOMMENDATIONS AND CONCLUSIONS

There is an urgent need for a cheap source of protein in order to overcome the protein malnutrition problem in Malaysia (New Straits Times, 1976). Considering the concern for the availability of protein foods, various traditional fishery products have not been fully utilized. The fault lies partly with the products; wider use is possible if the overall quality is upgraded. To encourage larger consumption of our local fishery products, the following recommendations are made:

1. The use of packaging materials should be made compulsory to protect the product during handling, storage and marketing. Plastic bags (though at times inappropriate) should be widely used to replace old newspapers. Exposure of food should be discouraged and be made an offence.
2. Hygiene and sanitation should be taught, stressed and enforced constantly to food handlers and processors.
3. There is an urgent need for product quality control. Product uniformity in terms of appearance, texture, flavour, viscosity and composition must be maintained. The moisture content of dried fish and shellfish should be standardized to prevent malpractice in pricing and to ensure long shelf-life in packaging.
4. Consumer education is necessary to change attitudes in order to promote the wider use of traditional fishery products.
5. Simple and low-cost processing equipment should be developed to assist the manual work involved in traditional processing. The Standard and Industrial Research Institute of Malaysia (SIRIM) is contri-

buting in this direction, particularly by working on methods for making kerupuk which will reduce time and labour (Ibrahim, pesonal communication). Such developments would be greatly appreciated.

6. The wholesomeness of local fishery products should be advertised by the Fisheries Development Board (Majuikan) and other Government agencies, aiming to educate the consumer and influence their choice of protein foods.

In conclusion, Malaysian fishery products are obviously underutilized and need to be improved for wider consumer acceptance.

REFERENCES

- Hanousek, J., Protective packaging for dried salted fish in Malaysia. Division of Food Technology Report, Ministry of Agriculture, Malaysia
1970
- Idrus, A.Z., Utilization of fisheries products in Malaysia. Seminar on the development of the fisheries sector in
1977 Malaysia
- Ismail, M.S., Accelerated fermentation of fish sauce using *Aspergillus oryzae* NRRL 1989 and freshwater fish.
1977a Conference on Food and Agriculture, Malaysia 2000
- _____, Microorganisms and the Malaysian proteinaceous foods. Seminar at Annual General Meeting of
1977b Malaysian Microbiological Society, 1977
- Merican, Z., Food quality control programme in Malaysia. International Development Research Centre workshop on food quality control. Singapore, 23-24 Feb. 1976
1976
- Ministry of Agriculture, Planning and Development Division. Seminar on the development of the fisheries sector
1977 in Malaysia
- New Straits, Times, Seminar on bridging the protein gap. 1 November 1976
1976

MEASURING THE QUALITY AND ACCEPTABILITY OF FISH PRODUCTS

by

P. Howgate
Torry Research Station
Aberdeen, Scotland

Abstract

Methods for measuring the quality and acceptability of fish products are described and compared. There are two types of sensory methods used for fish products: first, comparative methods such as pair comparison and triangle tests and second, scalar methods. Both types can be applied to work on product development and consumer testing. Sensory methods are considered to be far better than non-sensory methods which are not suitable for consumer testing.

INTRODUCTION

Quality and acceptability are closely interrelated. Indeed, the quality of a product can be defined as the aggregate of the various attributes of the product that contribute to its acceptability to the user or consumer. In spite of this, it is very useful to keep the two concepts separate when considering methods for their assessment and when interpreting test results

Quality is a property of the product which, in principle, could be measured by chemical or physical methods. In practice, however, many quality factors have to be assessed by sensory procedures because there are not suitable non-sensory ones available. Acceptability on the other hand, depends on the requirements and wishes of the consumer and can be measured directly only by the human observer. Acceptability of a product is also influenced by factors other than quality such as price, availability presentation and competition from alternative foods but these aspects will not be discussed in this review. Quality should be measured objectively, that is by procedures where any bias introduced by the person carrying out the test is small and minimized by training. On the other hand, acceptability tests, by their very nature, will be subjective, that is the results will very much depend on the person carrying out the test. People vary in their likes and dislikes of foodstuffs depending on personality, upbringing, familiarity with different foods and the consumption patterns of the society they live in. Personal bias is expected to be high in subjective tests and no attempt should be made to reduce it by training or persuasion. The terms subjective and objective should not be considered to be synonymous with sensory and non-sensory. In a well trained panel, using an objectively defined scoring system, the bias of the individual members will be small and the test as a whole can be classed as objective. This point is further elaborated in the descriptions of the tests given in this review.

Fish products are meant to be eaten and it is inevitable that their organoleptic properties are prominent among those factors that contribute to overall quality and acceptability. There are many research institutes throughout the world investigating the chemical composition and physical structure of foodstuffs and we have an increasing understanding of their condition to organoleptic properties but it will be a long time, if ever, before non-sensory tests can replace sensory test in measuring these properties. Hence in this review greater prominence is given to the sensory methods.

SENSORY METHODS

A sensory test requires a person, referred to as an assessor, to examine a sample using one or more of the human senses of vision, smell, taste and kinethesis corresponding to the properties in the product of appearance, odour, taste and texture. Only very rarely is the sense of hearing used. A chemical or physical property of the

product being examined acts as a stimulus to the appropriate sense organ. A signal is sent from the receptor via the nerves to the brain where it is interpreted to elicit a response. The fish technologist, however, is primarily interested in the two ends of his chain of events, and stimulus and the response, the intervening stages being more properly the concern of the psychologist and physiologist.

It is in the nature of sensory testing that the results from an experiment must be interpreted in terms of both the stimulus and response; they are not completely separable. Nevertheless, it is possible to classify the various test methods into those that are designed primarily to provide information about the response of assessors to a given stimulus and those designed to provide information about the stimulus that elicits the response. The former generally employ large panels of untrained assessors and are subjective; the latter generally use small panels of trained assessors and are objective. These are extremes and in practice many tests are a blend of the two types. An investigator, contemplating using sensory testing, should think carefully about what information he is trying to obtain before selecting a method from the many available. Where the properties of a product are to be measures, for example, in research and development or quality control, a procedure oriented toward assessing the stimulus is required. In product development and in marketing where the reaction of consumers to a product of known properties is being tested, a procedure oriented toward assessing responses is appropriate. The rest of this section on sensory methods reviews a number of procedures found useful in testing fish products, indicating in which areas of activity they are most appropriate.

Comparison Tests

These are tests where two or more samples are compared and a judgement is made about their relative properties. They do not provide absolute values of properties of products but one of the samples can be a reference or a standard and other related to it. The tests are easy to perform and the statistical evaluation of the data, when these are required, is straightforward merely requiring in most cases the consultation of readily available tables. The instructions that need to be given to the panel are not complicated and are readily understood by persons who are not used to sensory testing. The methods are therefore very suitable for market trials.

Though the tests are conceptually very simple they still require care in their execution to avoid distortion of the results by the experimental procedures used. The samples must be identified in such a way that the coding does not influence the assessors consciously or subconsciously. For example, coding the samples A and B or 1 and 2 in preference test is likely to induce a bias for the first member of the pair as A and 1 are associated with top quality. Best codes to use are three-digit random numbers, selected from tables published in statistical tests, or from the columns of the last digits in four-figure mathematical tables. The order in which the samples are presented to an assessor can also bias the result. The experimenter must tabulate all the combinations in which the samples can be presented and ensure that each is presented an equal number of times to the panel. When two products, A and B, are compared there are only two combinations AB and BA but where three, A, B and C, are being compared there are six possible presentations, ABC, ACB, BAC, BCA, CAB and CBA. Many of the texts in the bibliography give the combinations of samples for the standard comparison tests.

Comparison tests can be very discriminating and small differences between samples can be detected. At the Torry Research Station, panels of unselected and untrained assessors can distinguish amongst parts of the one fillet and between fillets from the same fish. Therefore, the experimenter must ensure that the samples presented to the assessors are truly representative of the product. This presents no problem for liquids but for solids, which would be the case for almost all fish products, there may be as much variation in sensory properties within the product as there is, on average, between products. The material being tested must be well mixed before sampling.

The experimenter must be careful when extrapolating the results obtained with a particular panel to a larger population. In general, comparison tests are used to investigate the response of a group of people to the products and not the products themselves. For example, a panel of unselected and untrained assessors may not find any differences amongst a particular set of products whereas a panel of trained assessors, especially selected for their acuity of taste, may do so. The differences amongst the products remain the same but the conclusions as

to their significance would be different in the two cases. The emphasis in comparison tests must be on the perception of differences not the differences themselves. This is another reason why comparison tests are at their best when used for product development and for testing consumer response.

Comparison tests can be considered, indeed are often termed, difference tests as the assessors are required to distinguish amongst samples. If the differences are small some assessors may refuse to make a choice. The experimenter should have an established procedure to deal with this situation. One approach is to accept the 'no choices' and either exclude them from the data or allocate them at random to the various possible outcomes of the test as though the assessors were guessing. This will reduce the effective panel size or dilute the data, but, in either case will reduce the sensitivity of the test. The other approach, and the one strongly advocated, is to force the indecisive assessor to choose even if he guesses. It has been established that, in cases like this, reluctant assessors choose in the same way as the rest of the panel. There are sufficient clues to establish a difference even though the assessor cannot formulate and rationalize them to make a conscious decision. Put another way, if there is any guessing to be done it is more effective for the assessor to do it than the experimenter.

Several comparison tests are described in manuals of sensory testing and indeed the investigator can devise his own; the three found most useful in testing fish products will be described. Full details of these tests are given in the manuals listed in the bibliography.

Triangle test

The triangle is designed to determine whether or not there is a perceptible difference between two products. Three samples are presented to the assessor; two are from one product and must be identical and the third is from the other product. The assessor is required to pick out the odd sample. There are six combinations for the presentation of samples. Calling the products A and B they are AAB, ABA, BAA, BBA, BAB and ABB. Each combination must be equally presented to the panel to avoid bias. This means that the size of the panel should be a multiple of six but it may not be possible to arrange this, in which case, the presentations should be balanced as far as possible and the remaining combinations selected at random.

A statistically significant result implies there is a perceptible difference but the test gives no indication of the nature of the difference, its direction or degree. The size of the difference can be inferred from the proportion of the panel making the correct choice; the higher it is the larger the difference. Information on the nature and direction of the difference can be obtained by including supplementary questions on the score sheet or by interviewing the assessors later but these approaches have been found to be unsatisfactory. Many assessors, unless they are trained to do so, find it difficult to describe how they arrive at their decisions, particularly when the difference is small. It is better to establish a difference by a triangle test in its simplest form and then to use a pair comparison or other test to determine its nature and direction.

Another drawback of the triangle test is that, in many situations, it is too sensitive. It can detect small differences which, though statistically significant, may be of no practical importance. This sensitivity may be useful in research work where the existence of a difference, even though small, can be a pointer to further experimentation but in the areas of product development and product testing it can be a distraction.

Pair comparison test

This test is designed to determine whether or not two products differ in intensity of an organoleptic property or in acceptability. Two samples are presented to the assessor who is asked to state which has the property to the greater degree or which sample is preferred. The test is simpler to carry out than the triangle test as there are only two possible presentations of the samples, AB and BA, and it is also easier for the assessor to understand and perform. The pair comparison test is basically a ranking test (described later) with just two samples. More than two products can be compared by submitting all possible pairs to a pair comparison test but this is rather cumbersome for more than three or four products.

If there is no difference or preference between the samples and the assessors are guessing, there should be equal selections of the two samples. The actual proportion choosing one of the samples can be tested for being significantly different from this 1:1 ratio. Tables are readily available for this in sensory testing manuals and text books on statistics, but there is one complication that the experimenter must understand. The data can be treated as a one-sided or two-sided test depending on the hypothesis set up before the experiment is performed. If the experimenter expects a result in one particular direction, it is one-sided. An example of this would be when it is known that one product contained more salt than the other; the expectation would be that the former should be rated saltier. Another example is when a process has been modified in the expectation that it would improve the product; in this case the new product should be preferred. On the other hand, if there is no prior expectation of a particular direction, for example, when similar products from two processors are being tested for preference or two species are being compared for toughness, a two-sided test must be used. Sensory testing manuals and statistical texts provide tables for both eventualities.

The pair comparison test is very flexible and can be used in a wide range of situations in research, quality control, product testing and consumer preference. A statistically significant result implies there is a perceptible difference, as does the triangle test, and gives the additional information about its direction. The test does not give a direct measure of the size of the difference or preference but this can be inferred from the proportion choosing a particular sample. Indeed it can often be more informative to note the proportion than to test for statistical significance. Take an example where a newly formulated product is compared with the existing one and 32 out of a panel of 50 consumers (i.e., 64 percent) preferred the new one. This proportion, tested as a single-sided test, would indicate a significant difference in preference but the proportion may not be high enough to warrant the costs of changing to the new formula.

It is possible to select specific properties for testing for intensity by the pair comparison test irrespective of others. For example, toughness only can be compared within a wide range of flavours or appearances. However, when the test is used for preference, selected properties cannot be specified because of the so-called 'halo effect'. For example, if the assessors are asked which texture they preferred and one sample had a particularly unpleasant flavour this would affect, consciously or subconsciously, the preference for texture as well.

Ranking test

In ranking tests several products are compared of an organoleptic property or for preference. The assessors are presented with three or more samples and asked to rank them for intensity or preference; lowest at one end of the row, highest at the other. The test requires a certain amount of concentration and persistence if there are more than about six samples to be ranked. Because of this it is not entirely suitable for use in market trials with unmotivated subjects. It can be used in research institutes and product development laboratories and is particularly effective for selecting and training assessors.

The treatment of the data from ranking tests is not as simple as in the previous two tests. There are two cases to be considered: (a) where the true ranking is known and the observed ranking is compared with it, and (b) where the ranking is not known and the observed data are used to evaluate it. The first case arises mainly in testing and training assessors. A series of samples are prepared of known properties, for example, by adding known amounts of a flavourous substance, and the assessors are asked to rank them. The correlation between the observed assessor's rankings and the known order is used as an index of the ability of the assessor. In the second case, the average rank for all the assessors is calculated and tested to establish that ranking could not have arisen by chance, i.e., by random guessing. Also, the rankings can be examined to determine if two or more samples share the same rank. The procedures for the statistical tests are given in textbooks and manuals but unless the experimenter is confident in his understanding of statistics he should consult a statistician. It is not unknown for manuals to give the wrong advice and textbooks to publish incorrect tables.

Scalar Tests

Comparison tests, by their very nature, provide relative and not absolute data on the organoleptic properties of products. Only samples tested at the same time can be related though comparisons between sessions can be made if reference standards are included in the set of test samples. Comparison tests do not give information about the size of differences. In general they test the response of the assessors to the products and not the products themselves.

Scalar methods are more versatile than comparison tests and are capable of providing quantitative information about the properties of products and the assessors' response to them. They are not so simple to administer by the experimenter or to perform by the assessor. In almost all cases, the assessors require at least a detailed briefing if not extensive training. Scalar tests are most often employed to measure the properties of products but subjective responses can also be scaled.

The concept of scalar tests implies there is some relationship between the intensity, or character, of a stimulus and the response to it. A scale is an ordered sequence of numbers on which the response can be placed to give a numeric measure of its strength. The values on a scale are measures of the psychological response and are not direct measures of the stimulus itself. The study of the relationship between a stimulus and the response to it is the branch of psychology called psychophysics and the corresponding study of quantitative relationships, psychometrics. A person using sensory testing frequently would be advised to have some knowledge of these subjects and suitable texts are listed in the bibliography.

When conducting a scalar test, samples of one or more products are presented to the assessors who are required to allocate the samples to positions on one or more scales. More than one property can be assessed, for example, the four main organoleptic properties of appearance, odour, flavour and texture; each can be further subdivided. For example, frozen fish can be scored for appearance, intensity of cold store odour and flavour, juiciness and toughness. Odour and flavour in this case would be scored on similar general intensity scales whereas the other attributes would have scales with specific descriptions. Some of the main types of scales will be described later but there are some features common to all.

The property to be scaled must be clearly defined and understood by the assessors. The length of the scale, the number of units into which it will be divided, and the terms used to define positions on it must be established, usually by discussion among potential panel members. Most scales are divided into five to ten units, the number depending on the ability of the assessors to discriminate among small differences in the property being measured. Highly trained and experienced assessors scoring a property with a wide range of distinctive organoleptic characteristics may justify having a longer scale but this can easily be accommodated by allowing fractional scores within a ten-point maximum scale. The end points of the scale at least should be defined and these definitions should encompass the expected range in the property. If only the ends of the scale are anchored in this way, the scale is referred to as unstructured; a scale with each unit described is fully structured. As an alternative to using numbers, the scale can be depicted on the record sheet as a line of some fixed length, say 100 mm. The line may or may not be subdivided into sections. The end of the line and possible intermediate positions on it are anchored as in a numeric scale. The assessor puts a mark on the line representing his estimate of the position of sample on the scale. The experimenter measures the position of the mark from the origin and this becomes the score.

With the important exception of hedonic scoring, scalar methods almost invariably require selected and trained assessors. They are selected for initial training on the basis of availability, interest and willingness to undertake a period of training; preliminary screening using threshold tests on a limited number of basic tastes or odours is of limited value. Retention on the panel depends on performance in the test. A panel size of four to eight assessors is adequate for carrying out most tests but it is useful to have a larger pool of trained persons from which a panel of this size can be drawn. This is to allow for assessors being absent or otherwise unavailable and also for some loss of panel members before a new set of recruits needs to be trained. Twice as many people should be selected for training as will be ultimately needed to allow for the elimination of unsuccessful candi-

dates. The performance of the panel as a whole and individuals within it should be monitored to detect and correct very erratic scoring or persistent biases.

A well trained panel using a well constructed scale will give results that can be considered objective, that is, they measure a property of the product in an unbiased manner. The panel's scoring should not drift with time and results should be comparable from session to session over a period of time without the need for including standards. At Torry we have used a particular type of scale for scoring freshness for about 30 years and although the composition of the panel has changed many times in this period, we believe the results we obtain now can be compared with those obtained when the procedure was established.

A wide variety of scales has been used for testing fish products, each requiring its own system of scoring. In the following discussion an attempt is made to group them into a few basic types.

Grading

This is the lowest level of scaling and gives the least quantitative data. It can hardly be classified as a scalar test but has been included here for convenience. Grading is the process of assigning a product to one of a few defined classes. The classes can be defined in terms of only one attribute but it is more usual to use several which may be sensory and non-sensory.

A simple example of grading is when a public health inspector classifies a product as fit or unfit for human consumption. Here, there are two classes and the judgement may be based on one or more properties of the product. Other examples are the specifications for quality published by the Codex Alimentarius Commission of the United States Department of Commerce for various fish products. In these there may be two acceptable grades, A and B, as well as an unacceptable one. These specifications include both sensory factors such as flavour, appearance and texture and non-sensory factors such as presence of bones, fins and foreign bodies. Size-sorting is a grading operation, performed universally at markets and in factories, where the factor is defined objectively but almost invariably estimated sensorily by eye.

It must be emphasized that grades within a classification scheme bear no mathematical relationship to each other even when numbers are used to label the grades. For this reason it is better to use descriptions such as extra large, large, medium, small and extra small or letters such as A, B and C to denote grade in order to avoid any temptation to perform calculations on the data. The data can be summarized only by statistics like frequencies of the separate grade or by the mode, the most frequently observed grade.

Trained or experienced assessors are used for grading. For size-grading, relatively little instruction is required and success depends on experience; for quality or public health grading, both training, possibly extensive, and experience are necessary. Grading is widely used in quality control and quality assurance. It is the basis of quality standards and one of the problems of drafting specifications is to make them unambiguous in their interpretation. It is in the nature of trade, and particularly of international trade, that the quality controllers employed by the buyer and seller rarely meet to ensure that their procedures and standards are the same. It is, therefore, possible for two groups of assessors, who are both working from the same specification, to disagree honestly as to the grade to be allocated to a batch of product. The difficulty of aligning the assessments of inspectors, who may be separated by large distances, is a major problem in quality control and could usefully be discussed at international meetings.

Freshness scales

Fish is a highly perishable commodity. Even when stored at 0°C, its shelf-life is in the region of 10-25 days, depending on species, and may be reduced to one or two days at tropical ambient temperatures. As fish spoils it develops an offensive appearance and odour and becomes unpleasant to eat, hence freshness is an important criterion for consumer satisfaction. Consequently, measurement of freshness is an essential part of quality assessment and quality control in the fish processing industry.

Freshness can be considered a continuum stretching from completely fresh, the state when the fish has just been caught, to completely putrid. The assessor is required to examine the sample and place it somewhere on this spoilage line. As fish lose freshness and spoil they pass through various recognizable stages. If these stages are separately described and allocated sequential numbers, they form a scale of freshness. There are several properties which change and which can be used to construct scales. Commonly used features are odour of the gills and belly cavity, appearance of the skin, eyes and flesh, texture of the raw flesh and the odour, flavour and texture of the cooked meat. Below are examples of two typical scales for odour and appearance based on those used at Torry Research Station:

— Gill odour

- 10 Sharp, iodine, starchy, metallic
- 9 Seaweed, shellfish
- 8 Freshly cut grass, less strong seaweedy and shellfish
- 7 Mousey, musty, milky, caprylic
- 6 Bready, malty, beery, yeasty
- 5 Lactic acid, sour milk, oily
- 4 Lower fatty acids, slightly sweet, fruity
- 3 Stale cabbage, stale turnips, sour
- 2 Ammoniacal

— Appearance

- 10 Eyes bulging, black and clear, bright skin colours, bright red gills
- 8 Flattening of eyes and slight loss of brilliance; slight dulling of skin colours; some loss of redness in gills
- 6 Eyes slightly sunken, grey with some cloudiness of the cornea; slime on skin, opaque and milky; some discolouration of the gills
- 4 Eyes sunken with milky white cornea; thick, creamy slime on the skin; brown discolouration of gills with some bleaching
- 2 Eyes very sunken and discoloured; skin covered with thick yellow slime; gills very discoloured or bleached and covered with yellow slime

The gill odour scale is fully structured, the appearance scale only partially so but, in both cases, experienced assessors will use scores in between the described points. Either scoring system can be used alone to measure freshness but, with trained and experienced assessors, the discrimination between freshness levels is better when the odour scale is used. Scoring for appearance is faster than scoring for freshness as the fish generally do not have to be handled and can be assessed where they lie in boxes or on the floor. It is particularly appropriate for grading fish at markets before auction. Scores on more than one scale can be combined but each should be weighted according to its relative precision in measuring freshness. This may not be easy to quantify formally but in the case of the two scales illustrated, odour and appearance, the former would have twice the weighting of the latter.

Quality scales

Quality has already been defined as an aggregate of separate factors each of which has some influence on acceptability. In principle, a score for overall quality could be determined by measuring each factor individually and adding together the separate values appropriately weighted. To some extent this is the approach taken by Codex Alimentarius, and similar standards, where various quality defects are allocated points according to their severity. The sum of these demerit points are deducted from a maximum value and the net score, which is really a negative quality score, is used to determine the grade. This approach requires a careful and tedious construction of a specification and, though this may be necessary for inspection of goods entering national or international trade, it is too unwieldy and inflexible for quality control in the factory or for product development. Instead a panel can be trained to recognize the quality of a product according to some agreed criteria of excellence and allocate a score directly. A suitable scale would be:

- 7 excellent
- 6 very good
- 5 good
- 4 fair
- 3 poor
- 3 poor
- 2 very poor
- 1 extremely poor

When used for factory quality control, the standards of good quality will be set by what can be achieved by the processing capabilities of the factory with the raw materials available and within the economic constraints set by the management. The assessors are then trained to these standards and the test procedure is used to monitor the products of the factory to check that the appropriate quality is maintained. When new products are being developed, there may be no guide based on actual marketing data to establish the criteria of quality for training the panel. In this case, the panel must agree within itself what constitutes good and bad quality based on its own preferences and on the acceptability of similar products.

Intensity scales

Grading, freshness testing and quality testing involves assessment of a combination of several properties and give an overall picture of the product. In many cases, a single attribute of quality can be isolated and its contribution measured separately. This attribute will change in amount, not character, as it varies throughout products of different qualities and can be measured on an intensity scale.

The assessors are trained to recognize the relevant factor in the presence of others and to score it on an intensity scale of which there are two types, unipolar and bipolar. The former is typically used when the intensity of odours and flavours is being measured; such a scale would be:

- 0 absent
- 2 slight
- 4 moderate
- 6 strong
- 8 very strong
- 10 extremely strong

This is a partially structured scale as the odd-numbered positions are not defined but selected and experienced assessors can differentiate intensities between the anchored points; a scale like this avoids the use of half units. This scale would be used to measure properties such as saltiness, tainting degree, level of cold store off-flavour and rancidity.

For solutions of single compounds or in simple mixtures there is a relationship between concentration and response. One of the simplest is expressed by the equation known as Bechner's Law:

$$R = b \log C + a$$

where R is the response on the intensity scale, C is the concentration of the stimulus and a and b are coefficients in the equations. It would be dangerous to assume that this relationship holds at all times for a single substance in a complex material like a fish product but, from experience, where the amount of a flavourous compound is known, either from chemical analysis or by the addition of known amounts to a reference material, intensity scores from a selected and trained panel correlate very well with the logarithm of the concentration. Individuals vary in the scores they give for a fixed stimulus and a large number of potential assessors should be screened for sensitivity before selecting a panel. The screening can be carried out using solutions of pure compounds of a similar nature to those being assessed in the product but the final selection should be made with the test material itself.

When the term used to describe a property has an antonym, bipolar scales can be constructed. These are often used in texture studies where pairs of opposites like tough-tender, hard-soft, elastic-plastic, dry-succulent exist. A typical scale using toughness as an example would be:

- 1 extremely tender
- 2 very tender
- 3 tender
- 4 slightly tender
- 5 neither tender nor tough
- 6 slightly tough
- 7 tough
- 8 very tough
- 9 extremely tough

In the case of texture scales, there is no simple way of relating sensory response to physical properties and panel members must be selected and trained using the product itself.

It is not easy to train assessors to agree when using intensity scales. The responses of individuals to a constant stimulus vary for physiological and psychological reasons and it is not possible to reconcile differences by training. What is considered moderately salty to one person can be very salty to another and both are correct within each person's frame of reference. Therefore, it is important to select, rather than train, a panel for intensity measurements for similarity of responses to a given sample. In spite of this, intensity tests can be a very powerful technique for use in research, quality control and product development.

Hedonic scales

As already mentioned, acceptability depends on factors other than the properties of the product and it is not common to use tests where assessors are asked directly to score for acceptability. The nearest approach is to score on a like/dislike, i.e., hedonic scale. One that is frequently used is:

- 9 like extremely
- 8 like very much
- 7 like much
- 6 like slightly
- 5 neither like nor dislike
- 4 dislike slightly
- 3 dislike much
- 2 dislike very much
- 1 dislike extremely

Hedonic scoring methods are designed for use with large panels of untrained assessors. They are meant to elicit the spontaneous opinions of the people tested and the experimenter must take care to avoid influencing the assessors, consciously or subconsciously, in their scoring. Hedonic scores give no information about the properties of the product; they must always be considered as measuring the properties of the group of people taking part in the test and their interaction with the properties of the product. The data from hedonic tests can be extrapolated to a larger population only if the panel is representative of that population. This is often difficult to achieve except by extensive marketing trials and the results of hedonic tests, carried out in a laboratory or factory, should be extrapolated with caution as the panel is most unlikely to be representative of the generality of consumers.

Data from hedonic tests can be treated as numbers and statistical operations such as calculating means, variances, analysis of variance and regression can be carried out. The purist may argue that it is not proved that the scale has equal intervals, i.e., the distance between scores 3 and 4 say, is the same as between 6 and 7, but this is a point that can be ignored for all but the most vigorous investigations. Certainly there is evidence to show that

untrained assessors tend to avoid using the highest and lowest values in a scale but once again it is not an important consideration in practice. A criticism that has been made of the type of scale listed is the inclusion of the 'neither like nor dislike' point at score 5. This allows people who are hesitant in making up their minds, as to whether or not they like a product, to avoid making a decision. Some scales do not include this indifference point but the above scale has been used without any obvious distortion.

The responses to products can be compared using the average scores from the panel but in many cases it is more informative to consider the distribution of scores. The liking for a product can take a bimodal distribution, some people liking it, some disliking it. To take a numeric, though artificial example, the conclusions to be drawn from a trial where half the panel gave a score 7 to a product and half a score 3, are not the same as one where all the assessors scored the product at 5 even though the panel mean values are the same. A marketing manager is more likely to be interested in the proportion of people scoring at or above a given level than in the average score since he may be willing to ignore a small fraction giving very low scores in favour of a high fraction giving moderately high scores. In comparing distributions of scores there should be at least 50 assessors in the panel. Note that this is not the same as getting 50 values by giving samples in duplicate to 25 assessors.

NON-SENSORY TESTS

Composition

The major constituents of fish flesh are inorganic compounds (usually referred to collectively as ash), water, protein and lipids. The complete analysis is important when nutritional quality is under consideration but otherwise is only rarely required in quality control. Each of these major constituents has a direct or indirect effect on the processing properties or quality of the product and it is not unusual for one or more to be determined for the purposes of quality control. Lipid content has a marked influence on the quality of cured and semi-preserved products; the best products are made from fish which have a limited range of lipid contents. Hence, it is not unusual for a factory making these products to measure the lipid content of the raw material, entering the processing plant, to check that it is within these limits. The shelf-life of dried, salted and cured products is dependent on water and salt contents and maximum values of the former and minimum values of the latter are often specified in standards or codes of practice for these products.

Methods for the determination of these constituents are available in textbooks and manuals for the analysis of foods and there is generally no problem in applying them to fish products. There may, however, be some problems in determining lipid content. The usual method of measuring the lipid content of food is to dry the product in air or with a desiccating agent such as anhydrous sodium sulphate then to extract the residue with a non-polar solvent such as diethyl ether of light petroleum. Fish oils are highly unsaturated and may readily oxidize under some processing or storage conditions. The oxidized lipids are not as readily soluble in non-polar solvents and in such cases low recoveries are obtained; a more polar solvent such as chloroform should be used instead.

Freshness

Fish starts to lose freshness as soon as it is caught but true spoilage does not start until spoilage micro-organisms become active. The reactions involved in loss of freshness and in spoilage are many and complex involving biochemical, chemical and microbiological processes. It is for this reason that sensory methods remain the most satisfactory way of determining freshness since assessors can be trained to integrate the effects of the various reactions to give an overall assessment. The major problem of using non-sensory methods is that freshness, although it can be considered a property of the fish, cannot be defined for the purposes of analysis in the same way as a chemical or physical component. Non-sensory tests must, therefore, be indirect measures of freshness and the utility of a test depends on a close association between changes in the property being measured and changes in freshness.

Many chemical tests have been proposed as indicators of freshness but only 3 have found wide acceptance. These are trimethylamine, total volatile base nitrogen and hypoxanthine.

Trimethylamine

Trimethylamine is formed by the reduction of its oxide by certain species of bacteria present in spoiling fish. It is, therefore, a measure of bacterial activity and its increase during spoilage parallels, to a large extent, the increase in total bacterial count. There are a number of methods of determining the amine but the most popular is a procedure, first proposed by Dyer, which uses its reaction with picric acid. The method is not specific and other amines present in fish, notably dimethylamine, can interfere. This interference can be reduced considerably when the appropriate analytical conditions are used.

Trimethylamine can be formed only if adequate amounts of the oxide are originally present in the flesh. Freshwater fish do not contain the oxide and the test is therefore not suitable for measuring spoilage in this group. Some species of marine fish, notably flatfish, pelagic fish and invertebrate species, have only small amounts and although trimethylamine content will increase during spoilage, the rise is small and the test is insensitive.

Total volatile base nitrogen

The determination of total volatile bases (TVB) is the longest established chemical method for measuring freshness. Fish flesh or a protein-free extract of it is made alkaline and the liberated bases are distilled titrated. The bases that distil from spoiling fish flesh are predominantly a mixture of ammonia, trimethylamine and dimethylamine. Ammonia is present even in very fresh fish and does not increase noticeably until the fish is very stale. Dimethylamine increases a little, or in some species does not appear at all, but most of the rise in TVB is due to the production of trimethylamine. Once again this test is not very suitable for those species which have little or no trimethylamine oxide.

The TVB content is not a fixed property of a particular sample but depends on the procedure used for its estimation. The reason is that ammonia is formed by decomposition of compounds present in the flesh or in the extracts; the amount of decomposition is dependent on the alkali used and the temperature of distillation. This is in addition to the ammonia already present in the sample. Therefore, standards which specify levels of TVB content should also specify the procedure to be used for analysis.

Hypoxanthine

Hypoxanthine is a product of the enzymatic decomposition of the adenosine triphosphate present in the muscle of all species of fish. The course of the reactions involved varies among species but, generally, hypoxanthine starts to accumulate soon after death and increases steadily during storage. The analytical procedure is straightforward but requires more expensive equipment than either of the two methods already discussed, hence its use is generally confined to research institutions.

Physical Methods

Chemical methods have the disadvantages that they require some time, a quarter to three quarters of an hour to perform, need laboratory facilities and skilled operators, and destroy the sample during the analysis. This means that they are not suitable for testing fish at markets or factory reception areas. They are more appropriate for monitoring factory production or testing batches of finished products. Recently an instrument which gives a quick, non-destructive measure of freshness has become available. It is based on an instrument developed at Torry Research Station and measures electrical properties of fish skin and muscle which change systematically

during storage. Once again it does not measure freshness directly since these electrical properties are not sensed by the consumer, but there is a correlation between the instrumental readings and freshness. A feature of the instrument, the GR Torrymeter, is its ability to accumulate readings over 16 fish and then display the average. This is particularly useful for testing batches of fish.

Frozen Fish

When fish is frozen the reactions that lead to loss of freshness and to spoilage are arrested. However, some chemical reactions take place that can lead to the production of off-odours and flavours and to alterations in texture. The rate of these reactions is temperature-dependent; at -15° they are fast enough to render many species unfit for consumption in six months or less whereas at -30° the changes are barely noticeable even after storage for a year.

The only satisfactory method of measuring these changes for the purposes of quality control is by sensory methods. Several chemical and physical procedures for the determination of changes during cold storage have been proposed and, though they have been used in research, they all have problems associated with the methodology or with the interpretation of the results and none can be recommended for routine use.

BIBLIOGRAPHY

The most comprehensive book on the sensory testing of foods is that by Amerine, Pangborn and Roessler (1965). It contains sections on the physiology, psychology, methodology and statistics of sensory assessment. The use of sensory analysis in quality control is covered in books edited by Herschodoerfer (1967) and Kramar and Twigg (1970). The American Society for Testing and Materials (1968) has published two useful booklets on sensory testing, one on basic principles, the other on methodology. Another manual is that by Larmond (1967). Terms used in sensory testing of foods are defined in British Standards (1975) and Jowitt (1974) has collected and defined terms relating to texture. For reader; who wish to study the psychophysics of tasting in more detail there is a good review of the subject by Pfaffman *et al.* (1971) and Stevens (1951 and 1960) has published very readable accounts of the mathematics of scaling.

There is no comprehensive manual of methods for determining the quality of fish products though Connell (1975) has written a useful review of quality control in general. It has a bibliography that directs the reader to more detailed texts. The book by Pearson (1970) on the chemical analysis of foods has a brief section on fish but a more comprehensive manual is that published by the Association of Official Analytical Chemists (1975). This book is often used as a source for standard methods of analysis. The proceedings of the FAO conferences on fish inspection and quality control, edited by Kreuzer (1971) contains many papers on measuring quality by sensory and non-sensory methods including a discussion on the determination of trimethylamine by the picrate method. A comprehensive review of methods for measuring freshness has been compiled by Gould and Peters (1971) and, though it does not describe any procedures, has an extensive bibliography which will enable the interested reader to find the full details. Mills (1977) has reviewed methods for measuring the quality of frozen fish.

REFERENCES

- Amerine, M.A., R.M. Pangborn and E.B. Roessler, Principles of sensory evaluation of food. New York, Academic Press 1965
- American Society for Testing and Materials, Basic principles of sensory evaluation, STP 443, and manual on sensory testing methods, STP 434. Philadelphia, U.S.A., ASTM 1968
- British Standards Institution, Glossary of terms relating to sensory analysis of foods. BS 5098: 1975: London, 1975 BSI

- Connell, J.J., Control of fish quality. London, Fishing News (Books) Ltd., 179 p.
1975
- Gould E. and J.A. Peters, On testing the freshness of frozen fish. West Byfleet, Surrey, Fishing News (Books)
1971 Ltd., 80 p.
- Herschdoerfer, S.M. (Ed.), Quality control in food industry. Vol. 1. London, Academic Press
1967
- Horwitz, W. (Ed.), Official methods of analysis. Washington, D.C., Association of Official Analytical Chemists
1975
- Jowitt, R., The terminology of food texture. *J. Texture Stud.*, 5 (3):351-8
1974
- Kramer, A. and B.A. Twigg, Quality control for the food industry. Vol. 1. Fundamentals. Connecticut, AVI
1970 AVI Publishing Company Inc.
- Kreuzer, R. (Ed.), Fish inspection and quality control. London, Fishing New (Books) Ltd., 290 p
1971
- Larmond, E. Methods for sensory evaluation of food. Ottawa, Canada Department of Agriculture
1967
- Mills, A., Measuring changes that occur during frozen storage: a review. *J. Food Technol.*, 10(5):483-96
1975
- Pearson, D., The chemical analysis of food. London, J. & A. Churchill
1970
- Pfaffman, C., L.M. Bartoshuk and D.H. McBurney, Taste psychophysics. *In Handbook of sensory physiology*,
1971 Vol. 4, Part 2. Chemical senses. Berlin, Springer Verlag
- Stevens, S. S., Mathematics, measurement and psychophysics. Handbook of experimental psychology. New York,
1951 John Wiley & Sons
- , The psychophysics of sensory function. *Am. Sc.*, 48:p. 226-53
1960

MARKETING INFORMATION AND ADVISORY SERVICE FOR FISH PRODUCTS IN THE ASIAN REGION

by

Fish Utilization and Marketing Service
Fisheries Department, FAO, Rome

Abstract

This is a project proposed for international financing in order to establish a Marketing and Advisory Service for Fish Products in the Asian Region. Lack of information and technical advice on new commercial development presents a major constraint for a more efficient commodity flow that would benefit producers, traders, consumers and government agencies. Such a service is expected to foster the expansion of national fisheries which will depend to a large degree on exports outside the region. The project, although primarily oriented to external trade, will also give support to domestic marketing development programmes.

The proposed project duration is three years and the provisional budget is U.S.\$ 2 million. Apart from the ongoing project in Latin America, similar activities are being considered for the Arab countries and the African region.

BACKGROUND

Persons involved with the fishery industry have generally realized the need for an international market information service for fish products, which would benefit the consumers and the producers, since it would lead to a more balanced supply situation on the markets, ensure a more regular pattern of fish prices and encourage the best use of fishery resources. Moreover, a number of producers in developing countries have encountered difficulties in meeting the high quality standards and increasingly stringent public health regulations of some importing countries. Rejections of fishery products from Asian countries by the U.S. Food and Drug Agency alone amount to several million U.S. dollars per annum. Producers and exporters often lack the required up-to-date information to make use of marketing opportunities, to diversify their business and to obtain the best return for their production. In other instances, governments want to ensure a high and undisturbed level of fish supply to the domestic market; thus they look for additional sources of products. In the region, considerable quantities of fish are wasted, either because of losses during handling and distribution or because unwanted species, caught incidentally in some fisheries, are discarded at sea or used as animal feed giving only minimal return to the fisherman.

An adequate fish market information service does not exist in the Asian region and neither private industry nor the government of anyone country may be expected to operate an international service of this type as successfully as a cooperative effort of countries with a common interest in this field.

Related projects

The project will establish close collaboration and current exchange of data with the FAO/UNDP project, Marketing Information Service for Fish Products in the Latin American Region (RLA/76/004), located in Panama City. The project will also establish close cooperation with national and regional fishery development projects in the Asian region, particularly the South China Sea Fisheries Development and Coordinating Programme (RAS/74/013), Manila, and the Indian Ocean Fisheries Development Programme (INT/76/012).

Government interest and support

Before preparing this document, an FAO/SCS Mission visited six countries in South East Asia (Philippines, Hong Kong, Thailand, Indonesia, Singapore and Malaysia); government and industry representatives expressed strong support for this type of project and wish to examine a draft project document for formal approval. Support for the idea was also received from the Government of Papua New Guinea.

PURPOSE

The purpose of this project is to set up a service which will enable the fishing industry in the Asian region to develop in accordance with present and future market demand and supply situation by providing information and technical assistance. Better information for and assistance to fishermen will result in more rational marketing operations and reduce the market power of intermediaries, who are often better informed than the producers about the market situation.

The objectives of the project are to ensure a balanced supply of fishery products to the participating countries and to make the best use of export opportunities within and outside the region. More specifically, the project will:

- (a) establish a service to provide information on marketing opportunities and supply prospects of fishery products within and outside the Asian region
- (b) advise on product specifications, processing methods and quality standards in accordance with market requirements
- (c) assist in the development of new marketing opportunities for fishery resources presently not fully utilized for human consumption
- (d) assist in the planning and implementation of national fish marketing information and research activities in the participating countries
- (e) train national staff from governments, institutions and industry in marketing development, and strengthen national institutions involved in this field.

WORK PLAN

It is anticipated that pre-project activities would be carried out using the offices of the South China Sea Programme in Manila as a base, during this period, the final location of the project headquarters will be decided in consultation with participating countries and the donor. The eventual location will be a capital city in South East Asia with good communication facilities.

An Executive Committee elected from representatives of participating countries, will provide the project with assistance and guidance when required.

It is thought that a few thousand entrepreneurs in the world fish trade would be interested to receive and pay for the type of information generated by the project. Such income, together with countries' contributions and funding from interested international institutions, could serve to finance the operations of this information service after the termination of the project. The feasibility of continuing the service on a self-sustained basis will be assessed in the third year of operation.

The project will collect and distribute relevant fish marketing information, partly by telex, with designated contact points within and outside the region.

The project will provide assistance in using the fish marketing information at government and industry level. It will also assist the establishment of national fish marketing information services.

The project will organize short workshops/training courses and will fund fellowship/study tours for staff from participating countries in order to prepare a sufficient number of persons in each country to continue this service after the termination of the project.

A collection of references and basic documentation on the marketing of fish products and related subjects will be established in the project headquarters. The project will prepare a catalogue of fishery products giving detailed specifications and processing instructions. Reports on trends in markets for selected fishery products will be issued periodically.

The overall conduct of project activities and the implementation of project objectives will be the responsibility of the Principal Marketing Adviser (Team Leader). The team experts working in the project will be fish marketing experts with specific experience in the following fields:

Communications and data processing—Marketing research—Fishery products—Export trade

Consultants will complement the expertise in the project in specific technical fields and, at specific times, allowance will be made for secretarial and clerical staff to support the project.

Provision will be made for duty travel, contractual service, operating expenses and supplies and materials. The equipment includes reproduction, communication and computation devices in special data storage facilities. Provision will be made for training in the operation of a marketing information service and short workshops/training courses on fish marketing development and export promotion will be organized. Fellowship/study tours will complement the training programme.

The government of the country in which the project headquarters will be located shall provide office space (about 300 m²), duly furnished and equipped, and secretarial and clerical personnel.

The governments of all participating countries will provide adequate budget allocation for the establishment and operation of national contact units through which the project will function.

In the third year of operation, a report will be prepared on the feasibility of continuing the Service on a self-sustained basis.

EVALUATION OF THE KEEPING QUALITY OF SMOKED FISH

by

M.B. Adebona
Department of Food Science and Technology
University of Ife
Ile-Ife, Nigeria

Abstract

Observations were made on the changes which take place in different samples of smoked tilapia during storage at 10°C and ambient temperature. Analyses of peroxide value, iodine value and total volatile bases were used as indices of spoilage.

At the end of the experiment, samples kept at low temperature were found to keep for a longer period (75 days in the case of unpacked samples) while those at ambient temperatures kept for only about 3-8 days. The shelf-life of the smoked fish was found to be related to the temperature and length of storage.

INTRODUCTION

Fish smoking has been identified as a very important method of fish preservation in Nigeria (FAO/UN, 1970) and the keeping quality of smoked fish is dependent on the extent of smoking and the relative humidity of the environment. Traditional methods of fish smoking have been investigated (FAO/UN, 1963) and efforts have been made to introduce improved types of ovens, including Altona-type ovens (FAO/UN, 1970). Such efforts have, however, not met with much success. A problem that has been identified in the storage of smoked fish in Nigeria is that of rapid deterioration. This study aims at determining the keeping quality of smoked fish.

The smoking of fish at Asejire is carried out by women. Fish to be smoked are descaled, usually gutted and then cleaned with water. Salt is applied to taste. Smaller fish are strung with sticks and placed on a wire gauze on top of a cylindrical smoke kiln, which is made of clay or a cut drum with an opening at one side for feeding in wood for smoke generation. Larger fish are cut into pieces salted and placed on top of the wire gauze for smoking. The fish are smoked for 30 min to 1 h to obtain a fairly uniform smoking, are turned over at least once during smoking. The finished product has a glossy appearance with a characteristic smoky flavour.

MATERIALS AND METHODS

Freshly smoked tilapia were obtained from Asejire on the Ife-Ibadan road. They were packed in polythene bags or left unpackaged and stored under refrigeration at ambient temperature. Moisture content was determined using an air oven. Ash content, lipid content, iodine value, peroxide value, total nitrogen and total volatile bases were determined using the methods described by Pearson (1970).

RESULTS

Analysis of the fresh and smoked tilapia is given in Table 1 and iodine values for the stored samples are shown in Table 2. The iodine value did not change appreciably in the unpacked refrigerated samples even after 12 weeks of storage. In the samples stored at ambient temperature, appreciable deterioration had set in within two weeks.

The changes in peroxide value (Table 3) also showed that the refrigerated, unpacked samples kept for up to 12 weeks compared to 5 weeks for the packed, refrigerated samples and 2 weeks for samples at ambient temperature.

The changes in total volatile bases are shown in Table 4. No appreciable change was observed in the unpacked refrigerated sample up to the fifth week, after which a gradual increase was observed, reaching a value of 50.35 mgN/100 g on the twelfth week. Samples kept at ambient temperature showed a more rapid increase in TVB content; a value of 49 mgN/100 g was obtained within two weeks of storage at ambient temperature. The extent of protein breakdown could be seen from the value of 150 mgN/100 g after 5 weeks of storage at ambient temperature. These results show clearly that deteriorative changes during storage of smoked fish are faster at ambient temperature (30°C).

Table 1

Analysis of fresh and smoked tilapia

Fish	Moisture (%)	Lipid (%)	Crude protein (%)	Ash (%)	Iodine value	Peroxide value ^{a/}	Total volatile base ^{b/}
Fresh tilapia	74.0	5.8	17.5	2.2	—	—	—
Smoked tilapia	46.5	7.4	40.5	2.9	173.5	3.2	17.5

a/ ml 0.002N sodium thiosulphate/g of sample

b/ mgN/100 g of sample

Table 2

Iodine value of smoked tilapia under different storage conditions

Storage (weeks)	Refrigerated		Ambient	
	Unpacked	Packed	Unpacked	Packed
0	173.5	173.5	173.5	173.5
2	170.3	160.1	119.0	136.6
5	166.5	144.9	87.5	105.0
12	161.1	128.1	—	—

Table 3

Peroxide value of smoked tilapia under different storage conditions
(ml 0.002N sodium thiosulphate/g of sample)

Storage (weeks)	Refrigerated		Ambient	
	Unpacked	Packed	Unpacked	Packed
0	3.27	3.2	3.2	3.2
2	3.4	4.9	13.9	13.0
5	3.9	9.0	49.1	44.8
12	8.9	24.8	—	—

Table 4

Total volatile bases of smoked tilapia under different storage conditions
(mgN/100 g)

Storage (weeks)	Refrigerated		Ambient	
	Unpacked	Packed	Unpacked	Packed
0	17.45	17.45	17.45	17.45
2	18.90	28.81	49.25	47.30
5	25.35	34.50	130.90	149.60
12	50.35	91.40	—	—

DISCUSSION

Observations on fish smoking procedures at Asejire indicate that the standards of sanitation and hygiene are low. It is not uncommon to see fish processors washing or cleaning the descaled and gutted fish with dirty water. Also, inadequate care is taken of their smoking kilns. Some of the wire gauzes on which the fish are spread are dirty. The finished products are left exposed on raised platforms near the road-side, thus exposing them to contamination by dust, insect infestation and possible infection by airborne micro-organisms.

During the period of study, there were occasional power cuts which would to some extent have reduced the keeping quality of some of the samples kept under refrigeration.

CONCLUSION

The keeping time of smoked fish is affected by conditions of storage. At lower temperatures there is a longer shelf-life, while at ambient temperatures there is rapid deterioration. Unpacked refrigerated samples kept for 75 days, packed refrigerated samples kept for 16-25 days, while those at ambient temperatures kept for 3-8 days.

REFERENCES

- FAO/UN, Report to the Government of Nigeria on improvements in the bulk smoking of bonga in Western Nigeria. Based on the work of M. Piatek, FAO/TA Fish Processing Expert. *Rep.FAO/EPTA*, (1756): 68 p.
- , Report to the Government of Nigeria on fishery development. Based on the work of M. Piatek, FAO Fish Processing Expert. *Rep.FAO/UNDP(TA)*, (2881):17 p.
- Pearson, D., The chemical analysis of foods. London, J. & A. Churchill
1970

PROCESSING AND MARKETING OF DRIED FISH IN CEBU AND BOHOL, PHILIPPINES

by

Cezar V. Guerrero
Bureau of Fisheries and Aquatic Resources
Intramuros, Manila, Philippines

Abstract

Fish drying, an old yet simple and practical method of fish preservation, is of substantial economic importance since many people living in coastal towns and barrios derive their income from the industry.

In spite of its economic importance, little is known about the economics of dried fish processing and marketing. This study was undertaken to provide further economic information on the processing and marketing of dried fish in a major producing area of the country.

INTRODUCTION

Fish are highly perishable and, as a result, require special handling or processing for preservation. Drying is the most common method of processing and is extensively practised in fishing barrios and towns and near some fish landings. Dried fish are important not only for human consumption but also as an animal feed. On Bantayan Island, off the main Island of Cebu, dried fish processing is a major undertaking. Some processors produce dried fish for human consumption, others produce dried fish mainly for fish meal. This has contributed to poultry production as fish meal is available at favourable prices. Today, Bantayan Island is noted as a major supplier of dried fish and eggs in the Visayan region. In Bohol, only a few processors were surveyed because of the limited production of dried fish due, in part, to the seasonal supply. Only commercial processors were included in this study.

Economic surveys report the annual consumption of dried and smoked fish to be 4.4 kg *per caput* in the country and 4.8 kg *per caput* in Central Visayas (Aviguetero *et al.*, 1976).

OBJECTIVES

The objectives of the study were to:

- (1) Determine the cost of, and returns from, processing dried fish,
- (2) Determine the marketing channels used for dried fish and the proportion passing through each channel,
- (3) Compute the marketing margins and costs for each type of outlet, and
- (4) Identify problems in the processing and marketing of dried fish.

METHODOLOGY

Seventy dried fish processors and 54 buyers (20 wholesalers, 8 wholesaler-retailers and 26 retailers) located in Cebu and Bohol were included in the study. Dried fish from Cebu are sold in Panay, Negros, Leyte and Mindanao; a separate study has covered operations in the first two areas (Guerrero, *et al.*, 1977).

Generally, dried fish processors are located along the coast and the respondents were chosen from processors in the area. The buyers associated with these processors were also taken as respondents. Likewise, all the buyers were interviewed until the product was sold to the consumer or left the study area.

The fish processors were classified into three groups, according to the annual volume of fresh fish handled, as follows:

Small processors: Less than 6 000 kg

Medium processors: 6 000 to 22 000 kg

Large processors: More than 22 000 kg

The study covered a 12-month period (May 1976 to April 1977)

THE PROCESS

The fish were either left whole ('tuyo') or split ('daing') for salting and drying. Species processed as tuyo were dilis, salmonete, red sal, sap sap and all species belonging under tunsoy. Those which were processed as daing were bisugo, dalagang-bukid, katambak, labungan, lapu-lapu, talakitok, barongoy, mulmul, lingero, lapgang, gong-gong, bodboron, boray-boray, margudlong, maya maya, apisonon and all species belonging under samaral.

Whole fish were sometimes washed before salting; for daing, the fish were split lengthwise, the gills and internal organs removed and they were then washed. All fish were washed with sea water after salting.

Depending on species, size, etc., the fish were soaked in brine in a large wooden vat for 2 to 12 hours; some of the species which were split were salted by spreading salt over the fish. From the salting vat, the fish were carried to the sea, washed and brought to the drying area where they were spread on bamboo slats and left to dry in the sun. Under normal drying conditions, this required one and a half to two days. In order to obtain uniform drying, the fish were turned two to four times.

The dried fish were sorted and graded according to size and species and were then packed in wooden boxes, sacks or baskets. The boxes of fish weighed about 27 kg while the weight of the sacks and baskets of fish varied depending on the species to be packed and the size of the container.

THE PROCESSORS

Location

There were 23 respondents in each of the small and medium-size groups of processors and 24 in the large-size group. Of the total, 62 were located in Cebu and 8 in Bohol.

Amount of fish handled

The fish were either caught directly or bought by the processors; 57 percent of processors caught their fish, 23 percent bought their fish and 7 percent acquired fish from both sources. Fifty five percent of fish was bought; 45 percent was caught. Those who caught fish operated in different ways. Some processors hired fishermen and, after deducting fuel, oil and other expenses from the value of the total catch (at prevailing prices), paid for the balance of the fish caught at an agreed price. Other processors reported 50-50 or 40-60 sharing between the operator and the hired fishermen after deducting expenses.

The amount and value of fresh fish, by species, handled by the processors is shown in Table 1. From a total of 2 752 kg of fresh fish, the small processors produced 1 309 kg of dried fish; medium processors produced 6 443 kg from 13 602 kg fresh fish and large processors produced 30 897 kg from 61 416 kg. The weight loss during drying depended largely on species and whether whole or split, and averaged 52 percent for small processors, 53 percent for medium processors and 50 percent for large processors; 50 percent overall.

For all species, the average price of fresh fish which were caught was P.Ps. 1.04¹/kg for small processors, P.P.s 0.80/kg for medium processors and P.Ps. 0.79/kg for large processors (Table 2) for fresh fish which were bought, the average prices paid per kg were P.Ps. 2.48 and 2.29/kg and P.Ps. 1.88/kg for small, medium and large processors, respectively. For each group of processors, the average price paid for all fresh fish bought was more than double the average cost of all fresh fish caught.

Labour

The labour requirements for the collection of fresh fish for processing and delivery of the dried fish are given in Table 3.

The time required for collecting the fresh fish, including loading and unloading, ranged from 2.4 man-days for small processors to 11.0 man-days for large processors and averaged 6.3 man-days overall.

Table 1

Total amount and value of fresh fish handled by fish processors

Tpye of fish	Size of processor						Average	
	Small		Medium		Large			
	Weight (kg)	Value (P.Ps.)	Weight (kg)	Value (P.Ps.)	Weight (kg)	Value (P.Ps.)	Weight (kg)	Value (P.Ps.)
<i>Caught:</i>								
Tunsoy ^{a/}	1 017	1 088.56	7 001	5 497.74	14 987	12 693.22	7 773	6 516.03
Galunggong ^{b/}	27	33.70	282	247.87	450	368.40	256	218.82
Bisugo ^{c/}	375	310.98	545	416.07	1 194	843.20	712	527.99
Alumahan ^{d/}	95	103.18	—	—	—	—	31	33.90
Other ^{e/}	367	428.54	1 239	1 051.71	7 331	5 096.55	3 041	2 233.76
Total	1 881	1 964.96	9 067	7 213.39	23 962	19 001.37	11 813	9 530.50
<i>Bought:</i>								
Tunsoy	124	146.74	557	588.26	15 526	15 676.15	5 547	5 616.18
Galunggong	—	—	870	2 608.70	3 640	7 455.73	1 534	3 413.39
Samaral ^{f/}	—	—	—	—	2 250	4 612.50	771	1 581.43
Alumahan	409	1 352.26	365	1 533.91	7885	27 818.48	2 958	10 486.08
Others	338	661.05	2 743	5 644.74	8153	14 707.81	3 808	7 114.58
Total	872	2 160.05	4 535	10 375.61	37 454	100 270.67	14 618	28 211.66
TOTAL	2 752	4 125.01	13 602	17 589.00	61 416	89 272.04	26 431	37 742.16

^{a/} Includes tamban, tulog, haul-haul, lopoy and kasig

^{b/} Includes marot, malatindok, bulao, lagao and matambaka

^{c/} Includes salmonete, red sal

1/ P.Ps. 1 = U.S.\$ 0.136 (April 11 1978)

d/ Includes anduhau, hasa-hasa and aguma-a

e/ Includes katambak, labungan, dalagang bukid, lapu-lapu, talakitok, sapsap, barongoy, dilis, mul-mul, lingo, lagpang, gonggong, bodboron, boray-boray, mangudlong, apison, and maya-maya

f/ Includes dangit and turos

Of the labour used, 47 percent was by the operator, 42 percent was hired and 11 percent was provided by the family. The cost or value of labour ranged from P.Ps. 229.60/kg for small processors to P.Ps. 3 105.64/kg for large processors and averaged P.Ps. 1 343.49/kg for all processors.

Capital investment and miscellaneous costs

The total capital investment for all firms averaged P.Ps. 708, equal to P.Ps. 5.39/100 kg of dried fish (Table 4). The most important items were land, drying facilities and processing plant. Investment costs included interest, depreciation, repairs and taxes. For all processors the average cost was P.Ps. 172.72, equivalent to P.Ps. 1.31/100 kg of dried fish.

Other costs incurred in processing dried fish were all cash expenses. For all firms, the total averaged P.Ps. 46.34/100 kg of dried fish (Table 5). The total for small processors was P.Ps. 52.53/100 kg of dried fish; medium processors P.Ps. 65.87/100 kg and large processors P.Ps. 42.18/100 kg. The major cost items were salt, containers and delivery expenses.

Table 2
Price of fresh fish (P.Ps. per kg)

Item	Size of Processor			Average
	Small	Medium	Large	
<i>Caught:</i>				
Tunsoy	1.07	0.79	0.85	0.84
Galunggong	1.23	0.88	0.82	0.86
Bisugo	0.83	0.76	0.71	0.74
Alumahan	1.09	—	—	1.09
Other	1.17	0.85	0.70	0.74
Average	1.04	0.80	0.79	0.81
<i>Bought:</i>				
Tunsoy	1.18	1.06	1.01	1.01
Galunggong	—	3.00	2.05	2.23
Samaral	—	—	2.05	2.05
Alumahan	3.31	4.20	3.53	3.55
Other	1.97	2.06	1.80	1.87
Average	2.48	2.29	1.88	1.93
Average	1.50	1.29	1.45	1.43

Table 3

Labour requirements (man-days per firm)

Operation	Size of Processor			Average
	Small	Medium	Large	
Collection	2.4	5.2	11.0	6.3
Cleaning	2.5	10.8	80.4	31.9
Salting	1.1	6.9	26.2	11.6
Sun-drying	4.8	25.1	177.3	70.6
Sorting, packaging ^{a/}	3.4	15.2	75.0	31.7
Delivery, selling ^{b/}	3.3	2.6	9.4	5.2
Supervision	16.1	19.3	48.4	28.3
Total or average:				
Per firm	33.6	84.9	427.7	185.6
Per 100 kg				
Fresh fish	1.2	0.6	0.7	0.7
Dried fish	2.6	1.3	1.4	1.4

a/ Includes grading

b/ Includes delivery to bus stations, piers and markets

Returns

Disposition of dried fish

The production of dried fish averaged 1 309, 6 443 and 30 897 kg for small, medium and large processors, respectively (Table 6). The average production for all processors was 13 140 kg of which 96 percent was sold for human consumption. Only large processors sold a sizeable amount for animal feed.

Sales

The income derived from selling dried fish for human consumption and for animal feed is shown in Table 7. Table 8 shows the amount sold for human consumption through the various outlets and the average price received. The reported prices received from each type of buyer varied widely depending upon the method of sale (collected or delivered), type and location of outlet, species and method of preparation of dried fish ('tuyo' or 'daing'). The high prices reportedly received by medium and large processors from wholesaler-retailers and retailers were a reflection of delivered sales of dilis, samaral and alumahan (which commanded higher prices) in Cebu City and Silay City and affected the average prices for these two groups of middlemen (Table 8).

Table 4

Capital investment^{a/} and costs (P.Ps. per firm)

Item	Size of Processor			Average
	Small	Medium	Large	
Land	152	287	460	302
Processing plant	36	78	225	115
Drying facility	99	163	307	191
Scales	9	14	43	22
Containers	16	8	28	17
Salting vat	31	56	94	61
Total	343	606	1 157	708
Costs:				
Interest	41.12	72.76	138.83	85.02
Depreciation	19.05	31.94	69.65	40.64
Repair	0.87	36.96	78.54	39.36
Tax	0.15	10.90	11.88	7.70
Total or average:				
Per firm	61.19	152.56	298.90	172.72
Per 100 kg:				
Fresh fish	2.22	1.12	0.49	0.65
Dried fish	4.68	2.37	0.97	1.31

a/ Represents value attributed to dried fish operations

Table 5

Miscellaneous processing costs (P.Ps. per firm)

Item	Size of Processor			Average
	Small	Medium	Large	
Land rent	6.70	26.17	59.33	31.15
Licence, fee	37.38	55.80	88.92	61.10
Electricity, water	—	—	28.00	9.60
Salt	418.15	2 647.83	7 141.75	3 455.99
Container ^{a/}	190.45	1 217.23	4 880.52	2 135.84
Collection	3.44	21.61	82.50	36.52
Delivery	31.48	258.64	738.25	348.44
Other ^{b/}	—	16.69	13.04	9.95
Total or average:				
Per firm	687.60	4 243.97	13 032.31	6 088.59
Per 100 kg:				
Fresh fish	24.99	31.20	21.22	23.04
Dried fish	52.53	65.87	42.18	46.34

a/ Includes disposable wooden boxes, sacks and baskets.

b/ Includes nails and wrapping and tying materials.

'Unsold' fish included dried fish which was consumed at home and given free; the amount ranged from 55 kg for small processors to 103 kg for medium and large processors. For all processors, the average was 87 kg worth P.Ps. 386.25.

Summary of costs and returns

A summary of the gross income, expenses and net profits of the processors is given in Table 9. For all processors, the gross income averaged P.Ps. 62 248.63 per firm or P.Ps. 473.73 per 100 kg of dried fish. The net profit was P.Ps. 16 901.67, equivalent to P.Ps. 128.62 per 100 kg of dried fish.

Table 6

Disposition of dried fish (kg per firm)

Item	Size of Processor			Average
	Small	Medium	Large	
Production of dried fish	1 309	6 443	30 897	13 140
<i>Disposition:</i>				
Cash:				
Sold for human consumption	1 240	6 340	29 621	12 646
Sold for animal feed	14	—	1 173	407
Non-cash:				
Home use	41	70	85	66
Given free	14	33	18	21
Total	1 309	6 443	30 897	13 140

Table 7

Income from dried fish

Purpose of sale and size of processor	Amount sold (kg)	Price per kg (P.Ps.)	Total Value (P.Ps.)
<i>For human consumption:</i>			
Small	1 240	5.12	6 352.62
Medium	6 340	5.03	31 895.09
Large	29 621	4.77	141 388.22
Average	12 646	4.83	61 043.07
<i>For animal feed</i>			
Small	14	1.30	18.26
Medium	—	—	—
Large	1 173	2.02	2 372.16
Average	407	2.01	819.31

THE MIDDLEMEN

Wholesalers, wholesaler-retailers, and retailers were the middlemen involved in dried fish marketing in Cebu and Bohol. Wholesalers who made 'collection' purchases from processors were known locally as viajeros or shippers. The data used in this section for purchases and sales of dried fish were collected in April 1977.

Amount purchased and sources

The 54 dealers who were questioned purchased 134 404 kg of dried fish during the month covered by the study. Of the total amount, 64 percent was bought by 20 wholesalers, 19 percent by 8 wholesaler-retailers and 17 percent by 26 retailers. The volumes purchased are shown in Table 10.

Table 8

Quantity and price of dried fish sold for human consumption

Size of Processor	Outlet							
	Wholesaler		Wholesaler-Retailer		Retailer		Consumer	
	Amount sold (kg)	Price per kg (P.Ps.)	Amount sold (kg)	Price per kg (P.Ps.)	Amount sold (kg)	Price per kg (P.Ps.)	Amount sold (kg)	Price per kg (P.Ps.)
Small	926	5.17	64	4.87	226	4.94	24	5.88
Medium	5 489	4.17	326	7.25	525	7.03	—	—
Large	22 932	4.03	4 308	8.10	2 381	5.91	—	—
Average	9 970	4.17	1 605	8.01	1 063	6.03	8	5.88

Amount sold and outlets

Sales by wholesalers over the month averaged 3 754 kg of which 65 percent was sold to retailers and 35 percent to wholesaler-retailers. Wholesaler-retailers had average sales of 3 146 kg; 52 percent to wholesalers, 30 percent to retailers and 18 percent to consumers.

Prices paid and received

Prices paid varied depending on species, type and location of source and method of purchase (collected or delivered). For all species, wholesalers paid on average of P.Ps. 4.05/kg to processors and P.Ps. 4.09/kg to other wholesalers (Table 11).

Prices received also varied depending on species, type of outlet and method of sale whether collected or delivered. For all species, wholesalers received an average price of P.Ps. 4.94/kg, wholesaler-retailers P.Ps. 5.80/kg and retailers P.Ps. 6.60/kg (Table 12). For each type of seller and each species sold, and the farther along the outlet in the market channels, the higher the price received.

Gross margins

The gross margins for the middlemen can be obtained by difference from the figures in Table 11 and 12. For wholesalers the gross margin was P.Ps. 0.86/kg, for wholesaler-retailers P.Ps. 1.03/kg, for retailers P.Ps. 1.12/kg.

However, since dealers had some non-cash uses of dried fish, the gross margins have also been computed another way. The total cost of purchases, the income derived from sales, the value of non-cash uses and gross margins are presented in Table 13. Sales consisted of dried fish sold for human consumption and animal feed while on-cash use included home use and on hand for sale.

Marketing practices and costs

The marketing practices involved in selling dried fish were collection sorting and packaging, storing, delivery and selling. The costs included the direct cost for hired vehicles, fuel for owned vehicles, hired labour, food for hired labour and storage fees. The marketing costs incurred per 100 kg of dried fish were P.Ps. 983 for all wholesalers, P.Ps. 8.10 for all wholesaler-retailers and P.Ps. 9.68 for all retailers.

Most of the containers used in marketing were provided by processors and dealers from outside the study area. However, other marketing investments included vehicles, baskets, kaing, tiklis, bilso and scales. For all dealers, the average investment cost ranged from P.Ps. 4.41 per 100 kg for wholesaler-retailers to P.Ps. 0.63 per 100 kg for wholesalers. Retailers had an average investment cost of P.Ps. 1.24 per 100 kg of dried fish.

Other expenses included stall fees, rent, business and other licences, taxes, insurance, and miscellaneous items such as electricity, wrapping paper, plastic bags and tying material. All wholesalers had total average expenses of P.Ps. 7.01 per 100 kg of dried fish, wholesaler-retailers P.Ps. 12.07 and retailers P.Ps. 12.35.

Table 9

Summary of gross income, expenses and net profits (P.Ps. per firm)

Item	Size of Processor			Average
	Small	Medium	Large	
<i>Income:</i>				
Cash:				
Sales for human consumption	6 353.62	31 895.09	141 388.22	61 043.07
Sales for feed	18.26	—	2 372.16	819.31
Non-cash:	183.99	332.03	371.40	296.89
Home use				
Given free	47.26	140.71	80.49	89.36
Total income:				
Per firm	6 602.13	32 367.83	144 212.27	62 248.63
Per 100 kg				
Fresh fish	239.90	237.96	234.81	235.51
Dried fish	504.36	502.37	466.75	473.73
<i>Expenses:</i>				
Cash:				
Fresh fish	4 125.01	17 589.00	89 272.04	37 742.16
Hired labour	31.74	66.08	1 345.37	493.41
Land rent	6.70	26.71	59.33	31.15
License, fee	37.38	55.80	88.92	61.10
Electricity, water	—	—	28.00	9.60
Tax	0.15	10.90	11.88	7.70
Salt	418.15	2 647.83	7141.75	3455.99
Container	190.45	1 217.23	4 880.52	2 135.84
Collection	3.44	21.61	82.50	36.52
Delivery	31.48	258.64	738.25	348.44
Repair	0.87	36.96	78.54	39.36
Other	—	16.69	13.04	9.95
Non-cash:				
Labour (Oper., family)	197.86	552.52	1 760.27	850.08
Interest on investment	41.12	72.76	138.83	85.02
Depreciation	19.05	31.94	69.65	40.64
Total expenses:				
Per firm	5 103.40	22 604.13	105 708.89	45 346.96
Per 100 kg				
Fresh fish	185.44	166.18	172.12	171.57
Dried fish	389.87	350.83	342.13	345.11
<i>Net profit:</i>				
Per firm	1 498.73	9 763.70	38 503.38	16 901.67
Per 100 kg				
Fresh fish	54.46	71.78	62.69	63.94
Dried fish	114.49	151.54	124.62	128.62

Net returns

The computed net returns for operator's labour, management and profit in selling dried fish are presented in Table 14. Wholesalers obtained an average net return of P.Ps. 0.69/kg, wholesaler-retailers P.Ps. 0.78/kg and retailers P.Ps. 0.89/kg of dried fish.

Table 10

Amount of dried fish purchased according to species and source (kg)

Buyer and species	Source		Total
	Processor	Wholesaler	
<i>Wholesaler</i>			
Tunsoy ^{a/}	469	1 791	2 260
Galunggong ^{b/}	272	607	879
Samaral ^{c/}	94	3	97
Alumahan ^{d/}	32	—	32
Sapsap	18	362	380
Pusit	—	4	4
Other ^{e/}	298	368	666
Total	1 183	3 135	4 318
<i>Wholesaler-retailer</i>			
Tunsoy ^{a/}	—	797	797
Galunggong ^{b/}	—	930	930
Samaral ^{c/}	—	1 004	1 004
Alumahan ^{d/}	—	116	116
Sapsap	—	38	38
Pusit	—	59	59
Other ^{e/}	—	273	273
Total	—	3 217	3 217
<i>Retailer</i>			
Tunsoy ^{a/}	27	156	183
Galunggong ^{b/}	1	156	157
Samaral ^{c/}	1	93	94
Alumahan ^{d/}	11	17	28
Sapsap	21	139	160
Pusit	1	18	19
Other ^{e/}	65	152	217
Total	127	731	858

a/ Tunsoy includes tamban, tuloy, haul-haul, lopoy and kasig

b/ Galunggong includes marot, malatindok, bulao, matambaka and lagao

- c/ Samaral includes dangit and toros
 d/ Alumahan includes anduhau, hasa-hasa and aguma-a
 e/ Other includes lapu-lapu, barongoy, dilis, bisugo, mulmul, dalagang, bukid, talakitok, lingo, lagpang, gihi, katambak, labungan, red sal, salmonete, gonggong and bodboron

GEOGRAPHIC FLOW

The geographic flow of dried fish between processors and dealers in Cebu and Bohol and in other areas is shown in Figure 1. In addition to the dried fish produced in the study area, dried fish also came from Negros (some of which originally came from Bantayan Island) and Zamboanga City. The major destinations outside the study area were Davao City, Butuan City, Cagayan de Oro City, Iligan City and Leyte.

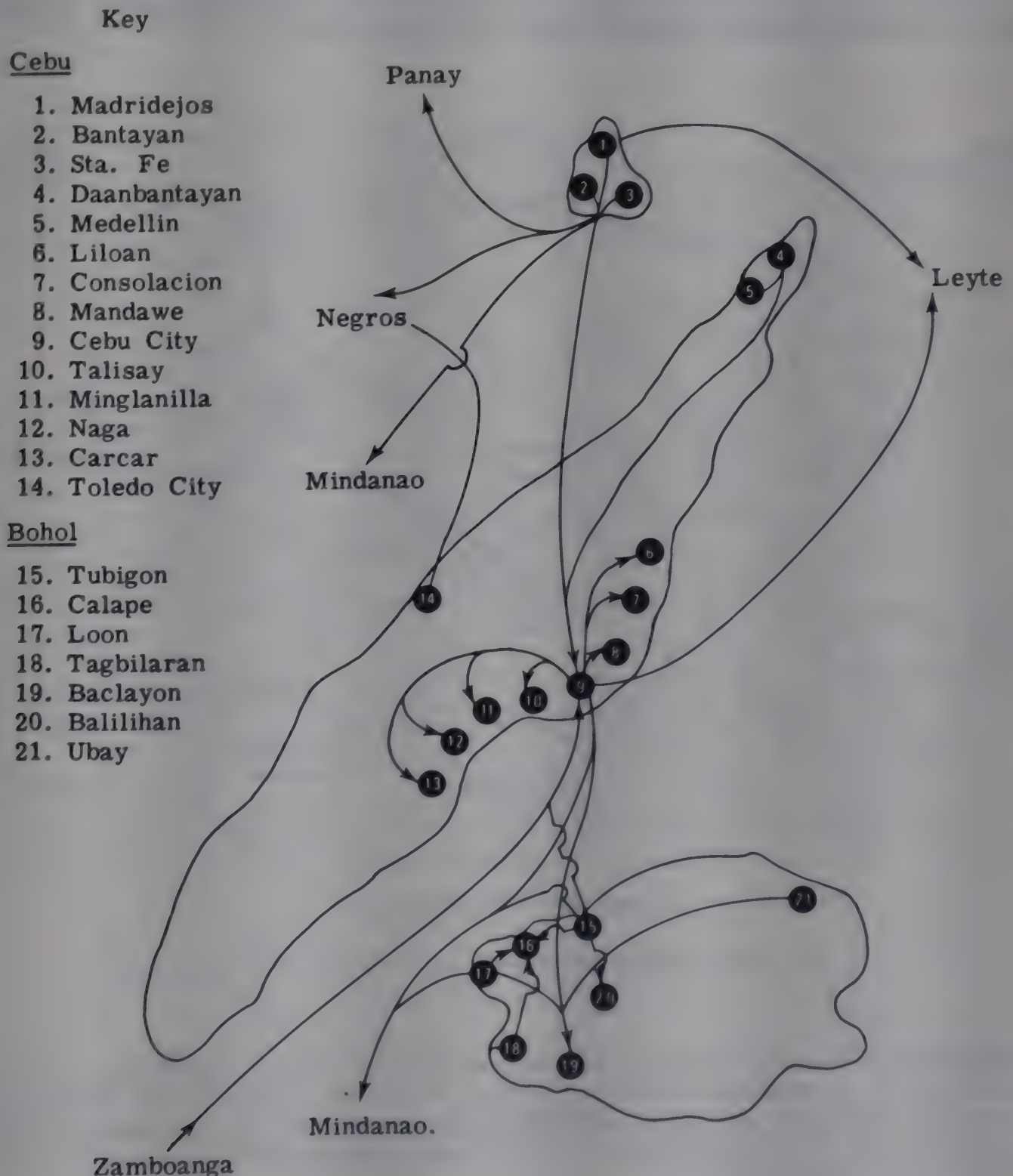


Figure 1 — Geographic flow of dried fish originating from major producing areas, Cebu and Bohol, 1976-77

The geographic flow shows only the operations of the processors and dealers surveyed. It is believed, however, that dried fish were marketed extensively in Cebu and Bohol but, due to the limitations of this study, only the major production and market areas were covered.

MARKETING CHANNELS

The marketing channels presented herein represent a weighted average of product flow since data include the outlets used by processors as well as the sources and outlets of dealers (Figure 2).

Of the total volume sold for human consumption, 89 percent was produced locally while the rest came from processors and wholesalers outside the study area. The major outlets used by local processors within Cebu and Bohol were wholesalers, wholesaler-retailers and retailers with 47, 11 and 4 percentage points, respectively, however, a minimal amount was also sold directly to consumers. The outlets used outside the study area were wholesalers, wholesaler-retailers and retailers in Negros, Leyte and Mindanao.

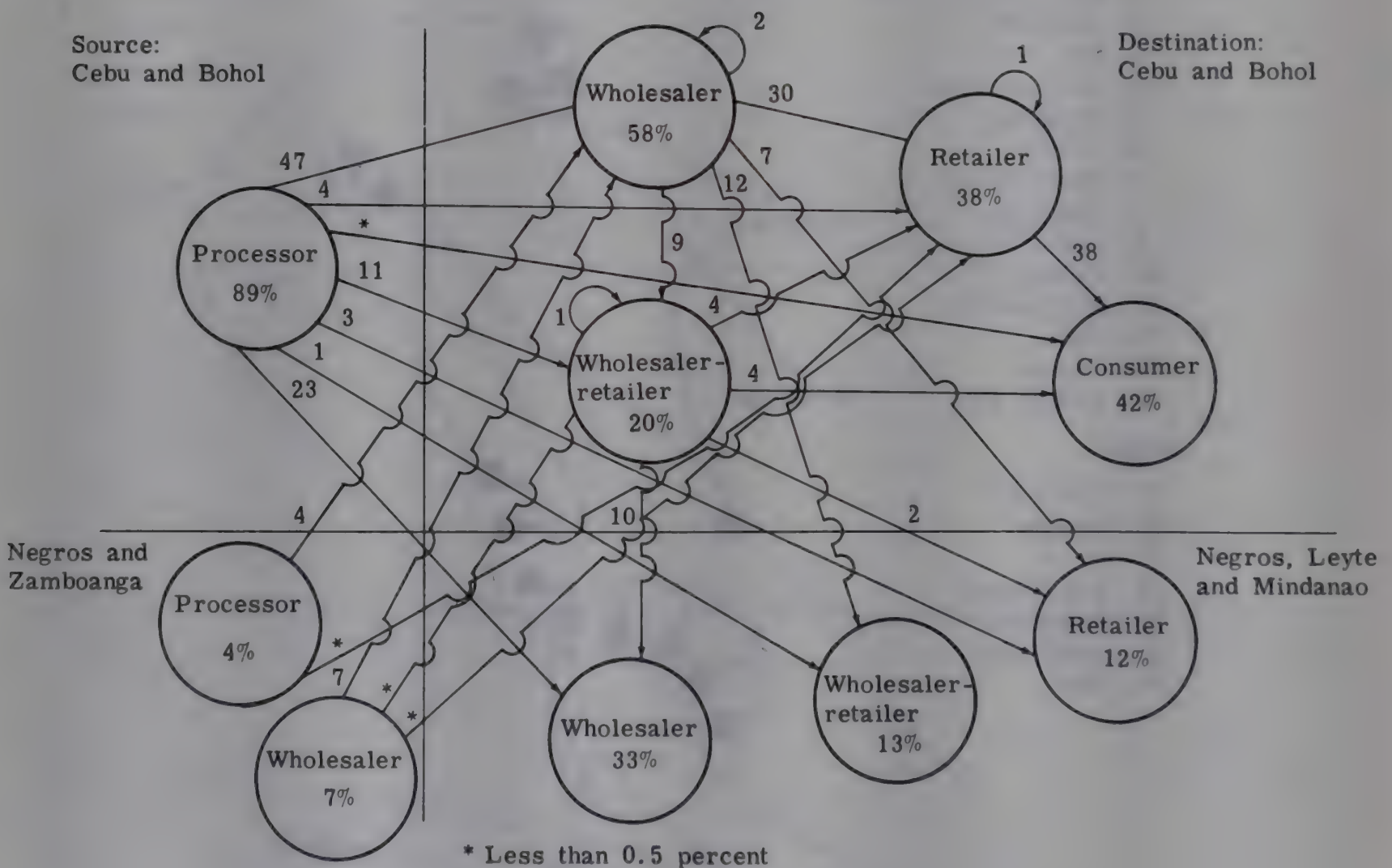


Fig. 2 — Market channels for dried fish sold for human consumption, Cebu and Bohol, 1976-77

Wholesalers sold 9 and 30 percent, to wholesaler-retailers and retailers, respectively, within the study area and 12 and 7 percent to wholesaler-retailers and retailers, respectively, outside the area. Wholesaler-retailers sold half the quantity handled to wholesalers outside the study area and the rest went largely to retailers and consumers within the area. Of the total volume 42 percent went to consumers within the study area and 58 percent to dealers in Negros, Leyte and Mindanao.

PROBLEMS

Lack of capital

Some fishermen and processors reported that they cannot increase production due to a lack of capital. Their fishing and processing operations were hampered by the high cost of gasoline, oil, salt and other items. The provision of credit should enable processors to increase production.

Fish trawl operation

Most processors on Bantayan Island were small fishermen and their fishing and drying activities were reportedly affected by the operations of fish trawls. There is an order restricting the operations of fish trawls to 7 km from the shoreline. But small fishermen questioned whether strict compliance with this regulation existed. In addition, it was requested that the distance limit for the operation of fish trawls should be increased for the benefit of small fishermen.

Table 11
Prices paid according to species and source (P.Ps. per kg)

Buyer and species	Source		Average
	Processor	Wholesaler	
<i>Wholesaler:</i>			
Tunsoy	3.54	3.88	3.81
Galunggong	3.55	4.00	3.86
Samaral	4.03	4.40	4.04
Alumahan	3.67	—	3.67
Sap sap	2.39	3.56	3.50
Pusit	—	11.00	11.00
	5.47	5.70	5.60
Average	4.05	4.09	4.08
<i>Wholesaler-Retailer:</i>			
Tunsoy	—	4.00	4.00
Galunggong	—	4.50	4.50
Samaral	—	4.96	4.96
Alumahan	—	4.28	4.28
Sap sap	—	4.00	4.00
Pusit	—	12.38	12.38
Other	—	5.90	5.90
Average	—	4.77	4.77
<i>Retailer:</i>			
Tunsoy	3.92	4.50	4.41
Galunggong	5.00	5.64	5.64
Samaral	4.80	5.42	5.41
Alumahan	4.90	5.45	5.24
Sap sap	4.77	5.00	4.97
Pusit	12.70	13.50	13.47
Other	5.80	66.10	6.01
Average	5.18	5.33	5.48

Supply of fresh fish

Drying operations in Bohol were limited to the supply of fresh fish caught locally and some species used for drying were seasonal.

REFERENCES

- Aviguetero, E.F. *et al.*, Regional consumption patterns for major foods. Manila, Department of Agriculture, 1976 Special Studies Division, Planning Service, September 1976
- Guerrero, C.V. *et al.*, Processing and marketing of dried fish. Part 2. Panay Island. Part 3. Negros, Manila, Department of Agriculture, Special Studies Section, Planning Service, (77-1) January 1977: (77-5) February 1977

Table 12

Prices received for fish sold for human consumption
according to species and outlet (P.Ps. per kg)

Seller and Species	Outlet				Average
	Wholesaler	Wholesaler— Retailer	Retailer	Consumer	
<i>Wholesaler</i>					
Tunsoy	—	4.00	4.60	—	4.45
Galunggong	—	4.60	5.20	—	5.01
Samaral	—	4.52	6.07	—	5.16
Alumahan	—	5.50	5.80	—	5.73
Sapsap	—	4.00	4.51	—	4.29
Pusit	—	—	12.50	—	12.50
Other	—	6.25	6.93	—	6.51
Total	—	4.81	5.00	—	4.94
<i>Wholesaler-retailer:</i>					
Tunsoy	4.48	—	4.80	5.00	4.56
Galunggong	5.40	—	5.80	6.20	5.79
Samaral	4.79	—	7.00	7.47	5.74
Alumahan	6.30	—	6.80	7.28	6.63
Sapsap	4.50	—	5.00	5.60	4.61
Pusit	12.70	—	13.41	13.80	13.35
Other	7.00	—	7.38	8.05	7.69
Total	4.98	—	6.46	7.03	5.80
<i>Retailer:</i>					
Tunsoy	—	—	5.00	5.52	5.51
Galunggong	—	—	—	6.52	6.52
Samaral	—	—	—	6.89	6.89
Alumahan	—	—	6.80	7.50	7.46
Sapsap	—	—	5.09	5.74	5.73
Pusit	—	—	—	14.50	14.50
Other	—	—	7.20	7.40	7.40
Total	—	—	5.95	6.61	6.60

Table 13

Purchases, sales and gross margins

Item	Purchases			Disposition			Gross margin	
	Kg	P.Ps. per kg	Total value (P.Ps.)	Kg	P.Ps. per kg	Total value kg	P.Ps.	P.Ps. per kg
Wholesaler:								
Purchases	4 318	4.08	17 617.44					
Sales:								
For human consumption				3 754	4.94	18 544.76		
For animal feed				30	1.50	45.00		
Non-cash uses:								
On hand				534	4.14	2 210.76		
Total or average	4 318	4.08	17 617.44	4 318	4.82	20 800.52	3 183.08	0.74
Wholesaler-retailer:								
Purchases	3 217	4.77	15 345.09					
Sales				3 146	5.80	18 246.80		
Non-cash Uses:								
Home use				11	6.34	69.74		
On hand				60	5.81	348.60		
Total or average	3 217	4.77	15 345.09	3 217	5.80	18 665.14	3 320.05	1.03
Retailer:								
Purchases	858	5.48	4 701.84					
Sales				802	6.60	5 293.20		
Non-cash uses:								
Home use				1	6.50	6.50		
On hand				55	6.02	331.10		
Total or average	858	5.48	4 701.84	858	6.56	5 630.80	928.96	1.08

Table 14

Net returns from sales of dried fish for human consumption
(P.Ps. per kg)

Dealer	Average buying price	Average selling price	Gross margin	Marketing cost	Net return ^{a/}
Wholesaler	4.08	4.94	0.86	0.17	0.69
Wholesaler— retailer	4.77	5.80	1.03	0.25	0.28
Retailer	5.48	6.60	1.12	0.23	0.89

^{a/} For operator's labour, management and profit

SESSION

V

SESSION V

**BY-PRODUCTS FROM MARINE RESOURCES
AND WASTE UTILIZATION IN THE FISHING INDUSTRY**

CONTENTS

DEVELOPMENT PROSPECTS FOR LESS ATTRACTIVE SPECIES OF FISH: AN ECOLOGICAL APPROACH	
by A. Herzberg and Niva Shapira	489
POSSIBILITIES FOR THE PRODUCTION AND APPLICATION OF LIQUEFIED FISH PROTEIN IN THE IPFC AREA	
by Kinumaki	492
BY-PRODUCTS TECHNOLOGY AND WASTE UTILIZATION	
by S.O. Canonizado	507
FISHERY BY-PRODUCTS AND UTILIZATION OF FISHERY WASTES IN INDIA	
by P.V. Prabhu P. Madhavan and K.G. Ramachandran Nair	515
PEPTONE FROM THREADFIN BEAM (<i>NEMIPTERUS JAPONICUS</i> BLOCK): PREPARATION AND SUITABILITY AS MICROBIOLOGICAL GROWTH MEDIA	
by K. Mahadeva Iyer, K. Gopakumar, A. Vasanth Shenoy, M. Arul James and M.R. Nair	520
FISH SILAGE TRIALS IN HONGKONG	
by P.J. Gaiger	527
FISH SILAGE: PREPARATION, UTILIZATION AND PROSPECTS FOR DEVELOPMENT	
by J.G. Disney, W.H. Parr and D.J. Morgan	543
PERFORMANCE OF PIGS FED ON DIETS CONTAINING FISH SILAGE EVALUATION IN THE COMMERCIAL SITUATION	
by J. Sumner	554
PREPARATION OF PROTEIN CONCENTRATES FROM WASTE FISH	
by R.G. Poulter and J.G. Disney	559
PROCESSING OF NON-COMMERCIAL AND LOW-COST FISH IN MALAYSIA	
by Q.L. Yeoh and Z. Merican	572
THE PRODUCTION OF FISH BALLS AND FISH CAKES IN SABAH AND THE POSSIBLE USE OF TRAWLER BY-CATCH FOR SUCH PRODUCTS	
by P.J.I. Snell	581
SALT MINCED FISH TRIALS	
by L.W. Regier, M.B. Wojtowicz, M. Fierheller and S. Varga	601

DEVELOPMENT PROSPECTS FOR LESS ATTRACTIVE SPECIES OF FISH:
AN ECOLOGICAL APPROACH

by

A Herzberg
Fishery Technology Unit, Department of Fisheries
Ministry of Agriculture, Haifa, Israel

and

Niva Shapira
College of Nutrition and Domestic Science
Hebrew University of Jerusalem, Rehovoth, Israel

Abstract

In highly industrialized countries, sophisticated technologies are continuously developed to utilize trash fish directly for human consumption rather than reducing it to fish meal and oil to be used for the production of more palatable animal protein.

In seeking an outlet for trash and surplus fish in a small fishery, it is suggested that their use for direct feeding to poultry, pigs and other animals could offer the following advantages:

- Raise the incentive to increase the catch;
- Prolong the fishing season;
- Avoid capital investment, energy expenditure and ecological pollution;
- Fit and level of an agricultural population and thus avoid socialological pollution;
- Pigs, poultry and eggs are more easily stored, transported and marketed than fishery products—as an additional source of animal protein they may improve the family diet.

An estimate of 30 kg surplus offal and trash fish per fishermen per day for 100 days per annum, i.e. 3 tonnes of fish, might yield about 500-600 kg of meat (pig or chicken) and about 1,000 eggs per year. About 600 kg of manure will be available for the growing of fruit and vegetables.

Attention should be paid to the possibility of over-fishing which may result from implementing this approach.

INTRODUCTION

Due to the population explosion, increased efforts are being made in the search to expand the contribution of sea food towards human nutrition. It is possible to increase this contribution through the intensification of fishing efforts, through raising the extent to which the catch is used, and by broadening the range of species caught.

With the increase in market demand, progressively more fish are caught but a number of low-value species in the catch are not used directly in spite of their nutritive value. The reasons for the rejection of these species are because: they may be too bony, too small, or tasteless for the North American or European customers; the

same fish, or very similar species, are readily accepted by Asian or Mediterranean populations. Also, species which have been previously rejected, eg. coalfish, sea bream, redfish, blue hake, etc. (many under a new name which sometimes borders on misrepresentation) have now become acceptable. Some of the species which are of small size are well-established food fishes (Naylor, 1963). Moreover, the motivation of the expectation that the use of small fish will be correlated with the population growth has motivated (Wiborg, 1976) to study copepods and others to investigate nyctophids or euphausiids.

Through technological sophistication it is possible to make products from non-edible fish, but they are not readily accepted in an affluent society, or they are too expensive for developing countries. Investing in technological research is therefore not expected to yield results which are immediately applicable. In developing countries, every resource has to be exploited but the production of, for example, high quality fish meal demands a large and regular supply of fish and a huge capital investment. This approach has therefore to be considered in relation to others.

INCREASING OUTLETS

Drying, salting and smoking are traditional methods of preservation which suit the conditions in poor countries but they do not promise significant change in term of increased outlets. In order to break the circle of a restricted market, prices, initiative, poverty, skill, facilities and the income of the fisherman have to be raised, and contracts and stability must be maintained.

The wastes, offal and leftovers may be fed to poultry and pigs or other animals in fresh, dried or ensiled form. In addition to the direct products (meat, eggs, hides, etc.), the manure can be used to improve the yield of vegetables and fruits. These products are more suitable to the elastic market conditions than fish; they can be stored or kept alive for better prices, whereas fish have to be sold at once at prices negatively correlated to the daily catch of any specific site. This approach fits well with the preference for labour-intensive techniques since unemployment is an ubiquitous problem in developing countries (Lawson, 1977).

In South-East Asia a major part of the catch is marketed fresh. An additional outlet could increase the income of the fisherman by:

- (1) Keeping prices above minimum levels;
- (2) Increasing the daily catch and extending the fishing season;
- (3) The economic gain from the animal products.

For the full-time fisherman, the suggested system should offer occupation for the wife and the children. This might serve as a mediating stage between fishing, farming and further cultures. Parttime fishermen could start animal husbandry which might open the family system for agricultural agents and create cooperation with other institutions; a necessary step for development. It could broaden the interfaces of the family members with the physical, social and institutional environment.

According to the ecosystem approach (Evans, 1956) to family (Hook and Paolucci, 1970; Bubolz *et al.*, 1977), the interfaces are the active sites for transactions, feeding backward and forward. These are mediated via the flow of energy, matter and information, which are the life blood of living systems. Broadening the interfaces is therefore a necessary step for improved adjustment to the environment which, under these circumstances, is synonymous to development in harmony with the environment.

This biological conversion in contrast to the chemical, industrial process, which reduces the fish to fish meal before using it for the production of animal protein, has further benefits; higher efficiency of transfer; compatibility with the life-style of the fishermen; minimization of foreign intervention and aid needed for development avoiding expensive investment and import of skilled manpower; prevention of the lowering of the socio-economic status of the fishermen and the agriculturists; avoidance of ecological pollution.

The questions are, whether soil and, on the seashore, water are available, how expensive labour is, whether alternative sources of income are present, etc. A rough estimate of the fisherman's gain based on 30 kg of extra daily catch for 100 days per year, i.e., about 3 tonnes of fish, will serve as an example. Under primitive conditions a sow may produce only 8 to 10 pigs per year. These require 5 – 6 kg of feed per kg of pork produced and 7 – 9 months to reach the market weight of about 60 kg (Pino, 1976). The feasibility of raising pigs on fresh fish has been demonstrated by Bacigalupo *et al.* (1962). Seasonal food shortages must be bridged by the use of locally preserved fish, either sundried or ensiled, depending on climatic conditions; the preparation and advantages of fish silage have been described by Disney and Hoffman (1976) and by Gildberg and Raa (1977). Marketing pigs at 15 – 20 kg will increase the efficiency of food utilization. Under the same conditions, poultry may produce one kg of meat for 5 kg of feed and lay 80 – 100 eggs yearly if fed some high-value protein. Hence the fisherman may be able to produce 500 – 600 kg meat and about 1,000 eggs by keeping a backyard flock of chickens and 1 – 2 sows.

The production of silage from the 3 tonnes extra catch might require 25 kg (about 0.75%) of formic acid and the same amount of propionic acid. Both would have to be imported. About 400 – 500 kg of grain or an alternative source of carbohydrate (possibly waste products) would have to be added to the silage as well. At the first stages, local breeds of animals, which are adapted to the environment, are preferable to imported ones though the introduction of high-performing strains should not be ruled out.

The approach described calls for close coordination between workers in fisheries and several branches of agriculture. It does not exclude industry but emphasizes the advantages of biological conversion for social, ecological and economic reasons. It is deeply embedded in the ecological conceptualization and it should therefore be stressed that any specific niche has to be studied before a solution can be proposed.

REFERENCES

- Bacigalupo, A. *et al.*, Preliminary report on the use of fresh anchovy (*Engraulis ringens*) in pig feeding. *In* Fish in 1962 Nutrition, edited by E. Heen and R. Kreuzer. Fishing News (Books) Ltd. London
- Bubolz, M. *et al.*, The human ecosystem; conceptual clarification. Michigan State University, East Lansing, 1977 Michigan (Ms)
- Disney, J.G. and Hoffman, A., A dried fish silage products. Paper presented to the Symposium on Fish Silage, 1976 Torry Research Station, Aberdeen, 27 May, 1976, 14 p.
- Evans, F., Ecosystem as the basic unit in ecology. *Science*, Wash., 123:1127-8 1956
- Gilberg, A. and Raa, J., Properties of a propionic acid/formic acid preserved silage of cod viscera. *J. Sci. Food Agric.*, 28: 647-53 1977

- Hook, N. and Paolucci B., The family as an ecosystem *J.Homes Econ.*, 62:315-8
1970
- Lawson, R.M., New directions in developing small-scale fisheries. *Mar.Policy*., 1(1):45-51
1977
- Naylor, J., Production, trade and consumption of small, shoaling pelagic species. *FAO Fish.Tech.Pap.*,
1973 (126):48 p.
- Pino, J.A., Poultry and swine production in Latin America-prospects for expansion. *In* Nutrition and
1976 agricultural development, edited by N.S. Scrimshaw and M. B'Ehar. New York, Plenum Press,
pp. 343-53
- Wiborg, K.F., Fishery and commercial exploitation of *Calanus finmarchicus* in Norway.. *J.Cons.CIEM*,
1976 36(3):251-8

POSSIBILITIES FOR THE PRODUCTION AND APPLICATION OF LIQUEFIED FISH PROTEIN IN THE IPFC AREA

by

T. Kinumaki
Tokai Regional Fisheries Research Laboratory
Tokyo, Japan

Abstract

The product known as 'liquefied fish protein' in Japan may be defined as a protein hydrolysate produced by an enzymatic liquefaction from whole, or parts, of fish. Liquefaction is carried out by enzymes already present in the fish or by adding commercial proteolytic enzymes prepared from bacteria, fungi or plants. For use as a food for the sick and for babies, milk replacers, condiments etc., this product is usually made as a powder by spray-drying.

The features which distinguish this product from other allied fermented fish products are:

- (1) Instant and complete solubility in water;
- (2) Low fat content;
- (3) Low ash content (if necessary, it can be reduced to 1 percent by means of electrodialysis);
- (4) High crude protein content;
- (5) Good amino acid balance;
- (6) Ability to improve taste and odour

With proper guidance and ample funding to develop the product, liquefied fish protein could be promising in the IPFC area since the techniques of liquefaction in traditional fermented fish products are known and raw materials, such as trash fish, and crude enzymes of plant origin, are available.

INTRODUCTION

Even with increasing population pressure and the difficulties of food production, considerable amounts of fish are being discarded at the time of catch, or are not utilized because of a poor demand among consumers although their flesh is of fairly high nutritive value. The fish are said to be unsuited to people's taste and are not economical to process.

In order to use these fish, fish protein concentrate (FPC) has been proposed. However, costly equipment and complex techniques are needed for the production of FPC. In addition, FPC does not meet local conditions, such as food habits or income, in the IPFC area.

The product known as 'liquefied fish protein (LFP)' in Japan shows promise in this regard. It is a kind of protein hydrolysate produced by enzymatic liquefaction from whole, or parts of, fish. Liquefaction is carried out by enzymes already present in fish or by adding proteolytic enzymes prepared from bacteria, fungi or plants. To make this product, no special equipment is needed and the techniques of liquefaction are not so

different from those of traditional fermented fish products. Crude enzymes of plant origin are also easily obtainable in the IPFC area.

The product is most suitable for invalid and baby food or as a milk replacer for raising young animals because of its high nutritive value and digestibility. Application as a condiment, peptone substitute or enriched protein food is also recommended.

MANUFACTURING PROCESS

The outline of the process is shown in Fig. 1. Whole fish are ground and used as the starting material. When a high quality product is required, fish meat emulsion (surimi) can also be used as the raw material. After grinding, the slurry is mixed with about an equal amount of water and with a suitable amount of a proteolytic enzyme. In the case of a refined commercial enzyme, usually 0.3-0.5 percent of the weight of the starting material is suitable. The amount should be adjusted to the proteolytic activity of the enzyme used, but care is needed because the proteolytic activity measured using casein as substrate is often not proportional to the activity when digesting fish protein. The addition of commercial proteolytic enzymes is not necessary when using a raw material such as small crustaceans, which contains highly active natural enzymes.

The enzymatic digestion of the fish protein is carried out for 4 hours at 45-50°C with continuous stirring. The temperature range for the optimum activity of natural tissue proteases is between 40 and 60°C and the digestion time is 4 hours. In the digestion with commercial enzymes, optimum conditions should be selected from experimental data or from the literature. However, to prevent putrefaction, temperatures of 20-30°C and digestion time of more than 10 hours are not advisable. Adjustment of pH is not normally necessary but, for the preparation of a product without bitterness, the pH is adjusted to 3.0-5.0 because an acid protease from a mould is required. After digestion, the temperature of the mixture is raised to about 90°C to inactivate the enzymes.

The aqueous and oily phases and the insoluble residue, consisting mainly of bones and other indigestible fish tissues, are separated by the use of a centrifuge or a filter press. If necessary, the aqueous fraction is then deodorized by azeotropic distillation with an organic solvent such as cyclohexane. By this means, most of the unacceptable odours are removed along with the solvent. The resulting aqueous fraction is concentrated under reduced pressure at a temperature below 60°C in order to get a higher yield in the spray drying procedure. In the digestion with acid protease, desalting by electrodialysis following neutralization is carried out after concentration.

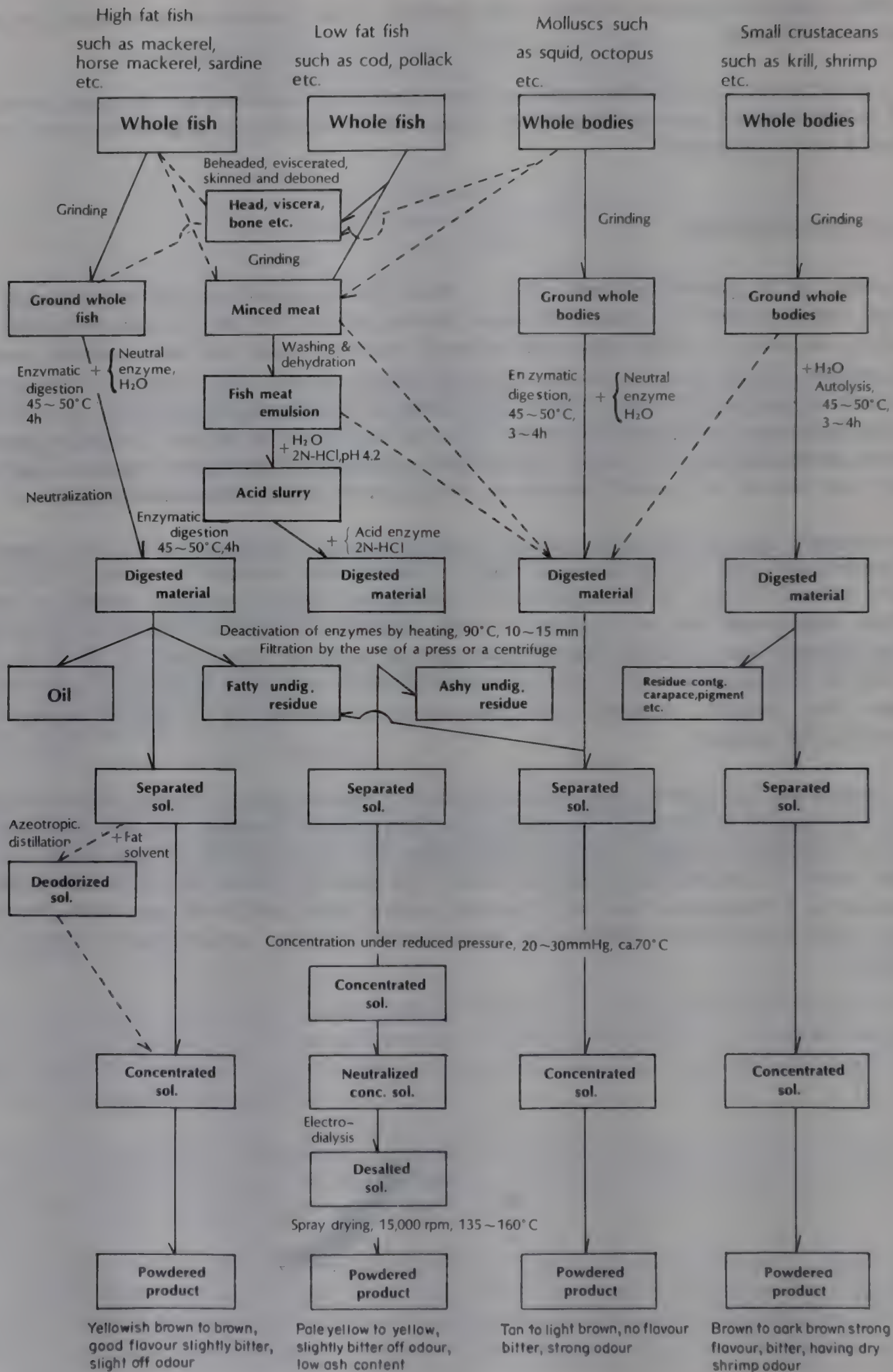


Fig. 1 – Outline of the manufacturing process of LFP. Main flow ———
Side flow - - - -

Finally, the powdered product is prepared by spray-drying and the remaining odour is removed completely in this operation. The yield in each operating procedure is shown in Table 1 and an analysis of the products obtained in each process is shown in Table 2.

Table 1

Yield of LFP Manufacture on a 15-60 kg Batch Scale

Operation	Percent yield	
	Weight	Nitrogen
Grinding	92-99	—
Addition of enzyme	180-200	95-98
Digestion and filtration	65-89	55-92
Deodorization and defatting	96-98	86-98
Condensation	36-47	95-100
Spray-drying	14-18	87-90
Overall process (Average)	5-15 (10)	37-90 (55)

SELECTION OF ENZYMES

The selection of the enzyme is most important in the production of LFP because the yield, the quality and the nutritive value depend upon the enzyme used. Commercial enzyme preparations are generally expensive. Therefore, the cost of manufacturing LFP can be reduced significantly by the use of a cheap enzyme. The properties of three commercial enzyme preparations were tested as follows. Washed pollack meat emulsion was used to minimize the effect of naturally occurring proteolytic enzymes. The yield was measured after 4 hours' digestion with 0.3 and 0.5 percent enzyme at optimum temperature and unadjusted pH.

The results are shown in Fig. 2. With pronase of 45 000 units per g (a fungal protease from *Streptomyces griseus*), 95 percent of the total nitrogen in the substrate was recovered into liquefied product. The LFP obtained tasted bitter and consisted mainly of lower molecular weight peptides. It also showed a fairly high amino acid content. Under the same digesting conditions, 65 and 45 percent of nitrogen were recovered by the use of commercial bacterial proteases, BNP from *Bacillus polymyxa* of 100 000 units per g and OFP-10 from *Bacillus spo-20* of 10 000 units per g, respectively. The products were composed of about equal amounts of polypeptide and lower molecular weight peptides, only a small amount (*circa* 2 percent) of amino acids was liberated. Bitterness of the product was considerably reduced in the digestion with bacterial proteases. Some weak bacterial proteases showed lower digestibility and often gave LFP of a very low nutritive value.

Table 2

Composition of products

Product	Moisture (%)	Protein ^{a/} (%)	Fat (%)	Ash (%)	VB-N (mg %)	pH
M a c k e r e l						
Ground whole fish	70-75.5	16-18	4.5-8.0	2.5-3.0	18-18.5	6.3
Digested solution	91-92	6.5-8.5	0.08	0.6	28-45	6.0
Residue	65-70	22-22.5	9.5-10.5	1.2-2.0	28-33	6.0
Deodorized solution	91-92	6.4-8.5	0.07	0.6	—	—
Concentrated solution	80-83	15-18	—	1.2-1.4	—	—
Powdered product (LFP)	2.4-4.9	87-88	0.16	7.3-7.9	—	—
Fish flesh	69-77	19-29	1.3-15	1.5-2.0	8.2-16.2	5.6
P o l l a c k						
Ground whole fish	77-77.5	15-18	1.7-3.8	2.5-3.0	12.5-43	7.0
Digested solution	88-99	6.4-8.5	0.09	0.4-0.6	32-52	6.8
Residue	72-75	13.5-18	—	7.8	22-53	6.6
Deodorized solution	92	7.0	0.06	0.3-0.6	37-55	—
Concentrated solution	—	—	—	—	—	—
Powdered product (LFP)	1.9-2.9	78-87	0.08	6.5	—	—
Fish flesh	79-82.5	16-20	0.7-0.8	1.1-1.6	7.6-21	7.1

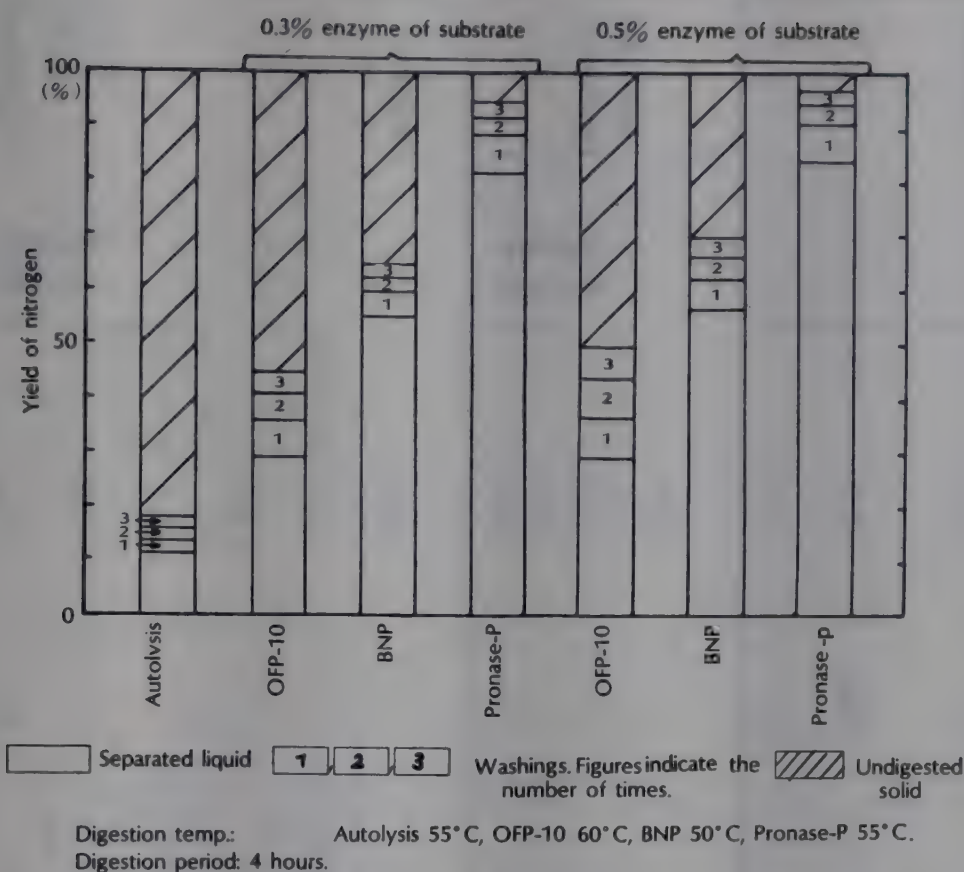


Fig. 2 — Effect of three commercial proteolytic enzymes on the yield of nitrogen in the digestion of washed pollack meat emulsion. (Yield of N is expressed as % of N in the hydrolysate to N in the substrate).

Papain latex, a crude protease prepared by drying the juice of the unripe papaw, showed digestibility of the same order as BNP and gave a similar product.

LFP almost without bitterness was obtained by using proctase, a mould acid protease from *Aspergillus niger* var. *macrosporus* DBD-0406. However, pH adjustment followed by neutralization and desalting is necessary in the digestion with this kind of acid protease. The yield of LFP is affected markedly by enzyme concentration, amounts of enzyme inhibitors and stabilizers, digesting conditions, etc., as well as the type of enzyme used.

PROPERTIES AND NUTRITIVE QUALITY

Proximate analysis

Analyses of LFP samples manufactured from various materials are shown in Table 3. Compared with other fish protein products, LFP is characterized by high protein, low fat and low ash, characteristics which give LFP its superior preservability and nutritive value.

Composition of nitrogenous compounds

The composition of nitrogenous compounds which are expressed as crude protein in the proximate analysis (Table 3) varies with materials and enzymes used.

In the autolysis of washed fish muscle emulsion, which contains little intrinsic self-liquefying enzymes, mainly polypeptides, are produced. Digestion with bacterial enzymes shows lower digestibility and lower

Table 3

No.	Sample	Digestion	Moisture (%)	Protein (%)	Fat (%)	Polysac. (%)	Ash (%)	Remarks
A	Whole mackerel	Pronase-P, 0.3% 55°C, 4 h	4.2	90.7	0.07	1.7	4.0	Defatted
B		BNP, 0.3% 50°C, 4 h	3.6	87.8	0.00	0.00	7.5	)
C		Papain, 0.3% 55°C, 4 h	5.3	87.7	0.03	1.4	4.1	)
D	Sardine	BNP, 0.5% 55°C, 4 h	7.3	85.9	0.81	—	7.6	)
E	Whole fish Meat	BNP, 0.5% 55°C, 4 h	8.5	73.3	0.90	—	7.4	) the same) sample
F	Whole fish	proctase, 5% 50°C, pH 4.2, 4 h	11.3	62.7	0.44	—	2.5	) electro-) dialysis
G	Meat		8.1	66.7	0.54	—	2.6	)
H	Alaska pollack	BNP, 0.3% 50°C, 4 h	1.9	87.0	0.08	—	6.5	Defatted
I	Whole fish Meat	BNP, 0.7% 50°C, 3 h	4.9	84.0	0.08	—	6.4	
J	Washed meat	BNP, 0.5% 50°C, 4 h	4.4	88.3	0.14	—	3.2	
K	Whole fish	proctase, 5% 50°C, pH 4.0, 4 h	11.5	65.2	0.46	—	1.7	)
L	Waste	proctase, 5% 50°C, pH 4.0, 4 h	13.8	68.4	0.51	—	1.8	) electro-) dialysis
M	Washed meat	proctase, 1% 50°C, pH 4.2, 4 h	4.5	81.0	0.09	9.3	5.0	) the same) sample
N		Enzyme I. 0.5% 50°C	4.9	84.8	0.05	1.4	8.9	)
O	Whole horse	Pronase-P, 0.3% 55°C, 4 h	6.2	87.4	0.04		6.1	Defatted
P	mackerel	Pronase-P, 0.3% 55°C, 4 h	6.1	77.7	0.0		5.6	) the same) sample as Q and R

Q	Whole horse mackerel	BNP, 0.3% 50°C, 4 h	8.1	74.3	0.0	0.0	5.6	)
R		BNP, 0.3% 35°C, 4 h	8.6	78.5	0.0	0.0	5.8	)
S	Antartic krill	Autolysis 45°C, 3 h	5.9	69.4	0.07	—	11.9	)
T		BNP, 0.2% 45°C, 3 h	5.4	71.1	0.08	—	13.3	)
FPC	Fish flour		6.3-10.8	78.0-82.3	0.13-0.19	—	12.9-13.8	U.S.A.
	Fish soluble		7.1-9.7	52.1-66.8	2.8-10.9	—	12.1-24.9	
	Washed pollack meat paste		33.8-46.5	35.2-48.2	4.1-11.2	—	3.4-10.8	
	Fish sauce		76	14	Ø	—	3	
			57.8-71.8	3.8-15.3	0.0-0.02	—	24.8-30.2	

molecular weight peptides are produced together with polypeptides; only a small amount of amino acids is liberated. The main components of LFP obtained in the digestion with a fungal enzyme from *Streptomyces* are lower molecular peptides and amino acids.

The complication of the composition of LFP from whole fish is due to the presence of various water-soluble nitrogenous compounds and the effect of naturally occurring enzymes, which are different in quantity as well as quality.

Dissolving properties

Properties of LFP such as solubility, wettability and speed of dissolution are excellent when compared with those of sugar or dried milk. However, LFP prepared by short-term digestion is inferior in these properties as seen in Fig. 3. LFP dissolves easily in water and can be incorporated into soup, bread, cereals, baby foods and the like.

Storage

LFP is very hygroscopic and, if wet, is easily spoiled. However, LFP kept in a dry atmosphere is very stable and can be preserved for more than one year at room temperature.

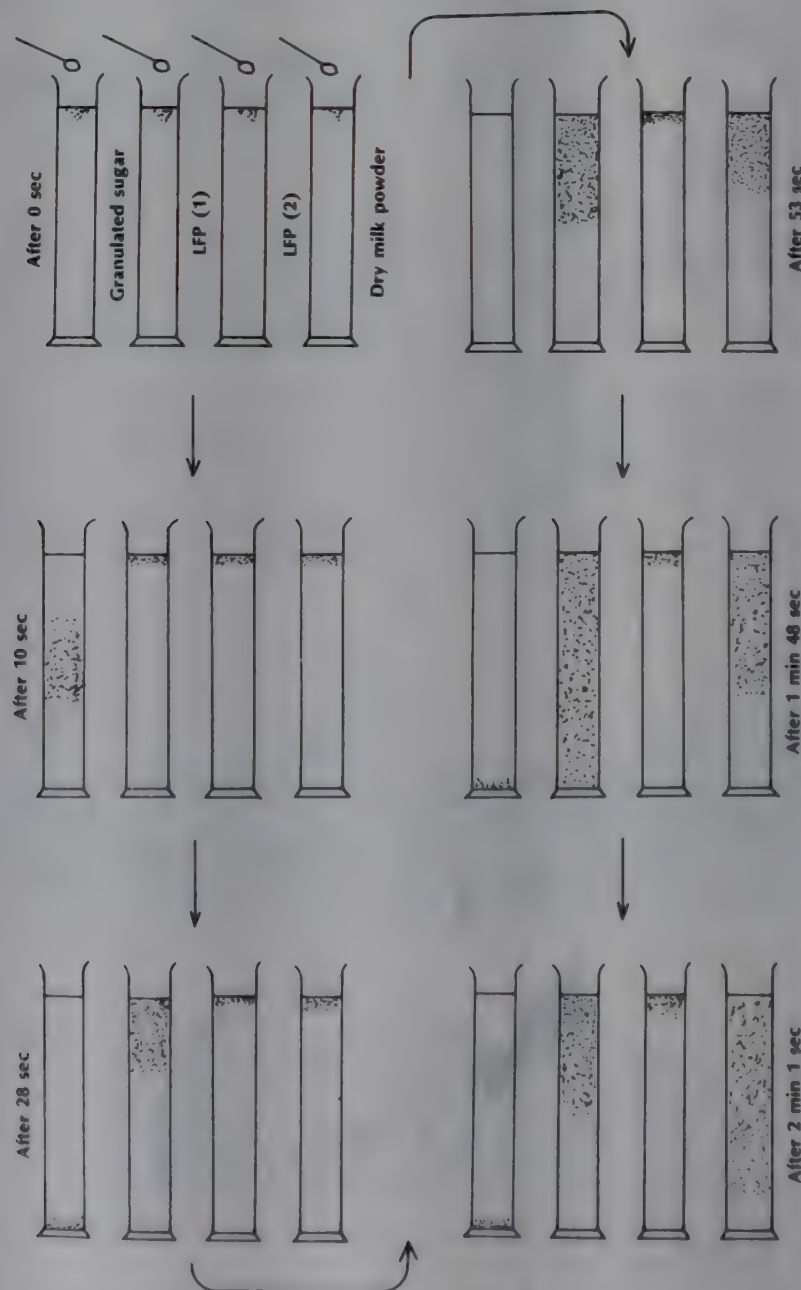


Fig. 3 — Comparison of the solubility of LFP with granulated sugar and dried milk powder.
LFP (1): digesting time of 4 h
LFP (2): digesting time of 30 min

Nutritive value

Rat feeding tests show that the biological value of LFP is higher than that of milk casein. However, when the raw material is precooked and digested with weak proteolytic enzyme, the nutritive value decreases. The low nutritive value is attributable to the imbalance of essential amino acids, especially the low tryptophan content caused by the slow rate of digestion; tryptophan tends to remain in the undigested residue. In this case, the yield of LFP decreases and much of the protein is left in the insoluble fraction. Therefore, the selection of enzymes and the yield of LFP is very important to obtain LFP of high nutritive value.

Amino acid composition

The pattern of essential amino acids of LFP is shown in Fig. 4 to 6.

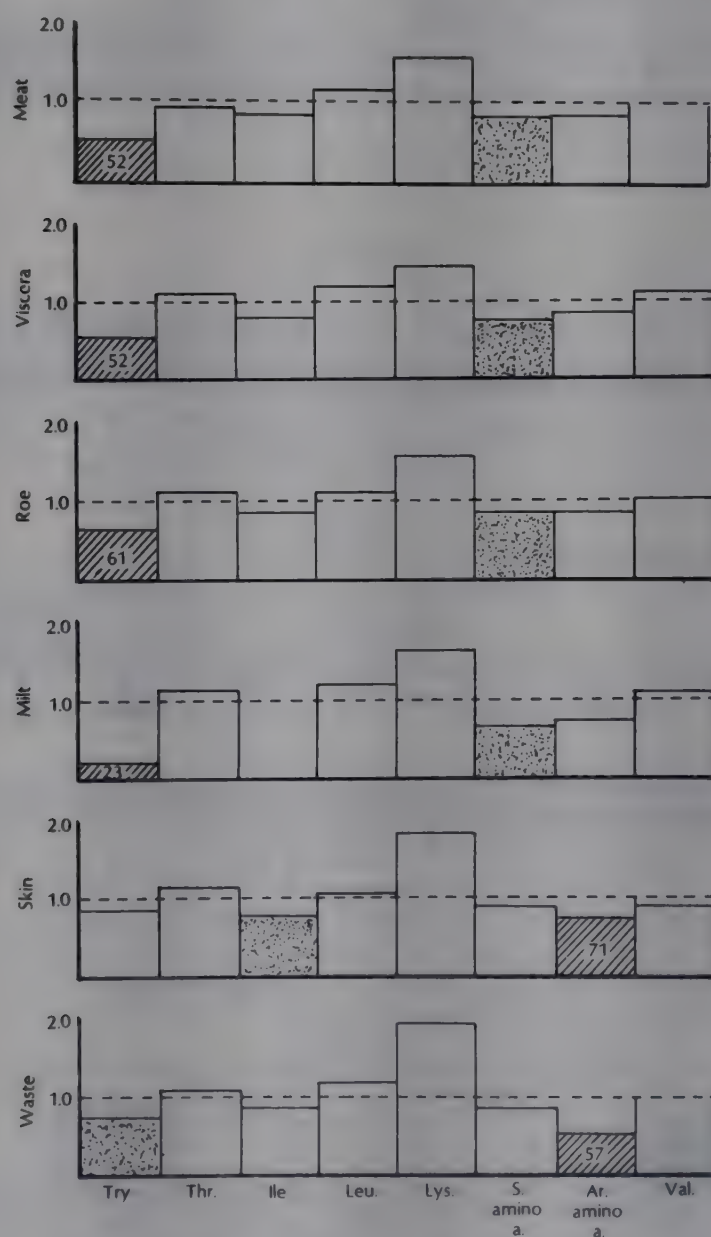


Fig. 4 — Pattern of essential amino acids of LFP made from different parts of Alaska pollack compared with that of whole egg. (Expressed as the ratio to the pattern of whole egg.) 4 hours' digestion with BNF at 50°C. The diagonally shaded and the dotted portions identify the first and second limiting acids respectively.

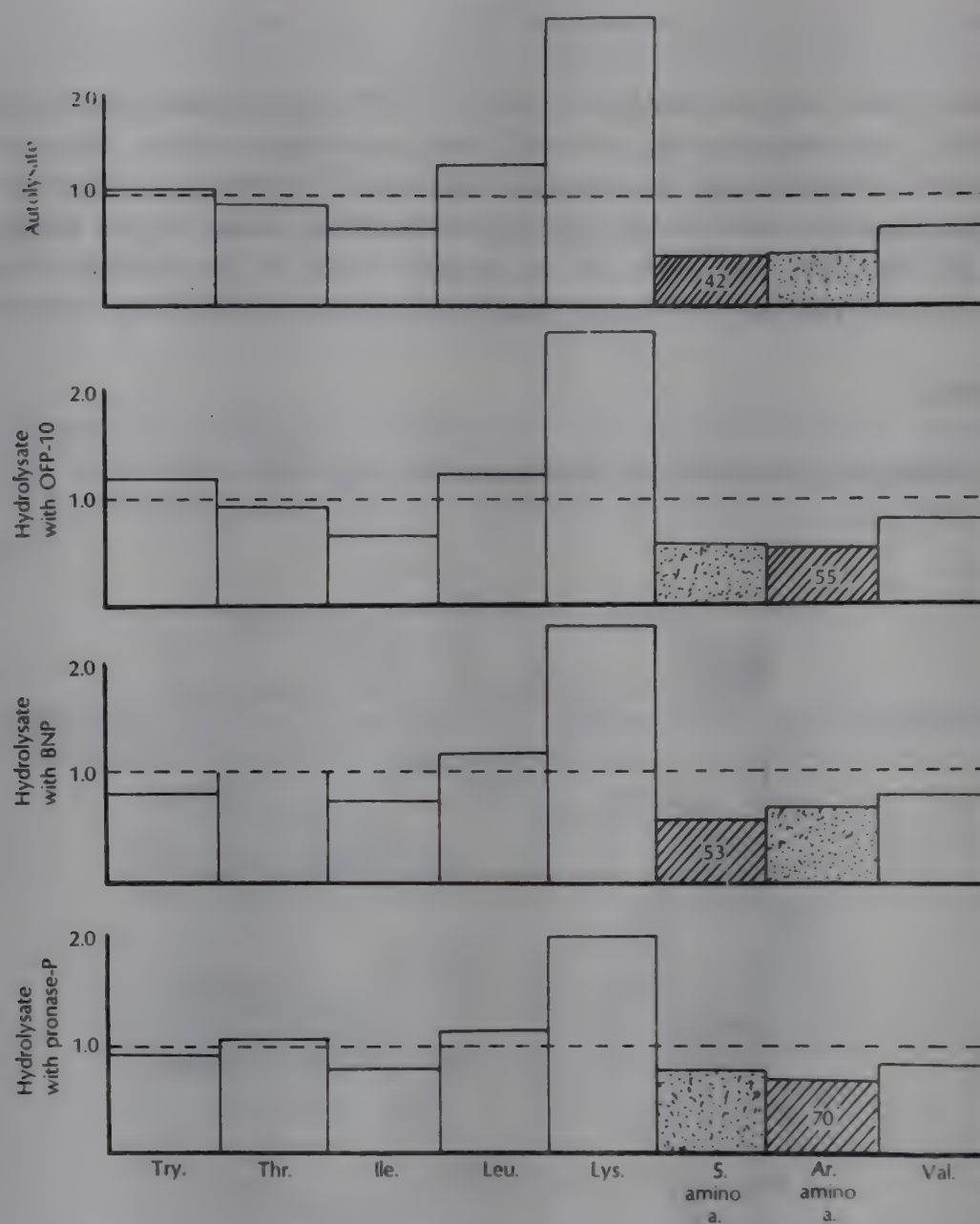


Fig. 5 — Pattern of essential amino acids of LFP made from washed Alaska pollack meat emulsion by different enzyme preparations. Coding same as Fig. 4.

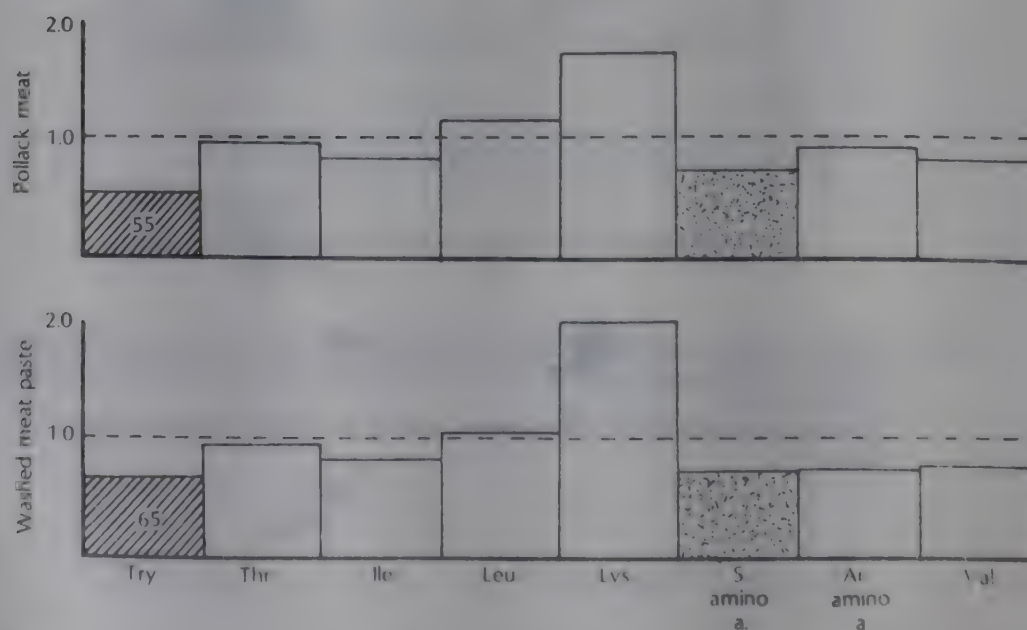


Fig. 6 — Pattern of essential amino acids of unwashed meat and washed meat emulsions of Alaska pollack. Coding same as Fig. 4.

In LFP samples made from flesh, viscera and roe, the first limiting factor is tryptophan, followed by the sulphur-containing amino acids. LFP made from milt has a very low chemical score due to lack of tryptophan. The first limiting amino acid in LFP made from skin is isoleucine; the chemical score is high but E/T and E/TA ratios are low.

With LFP produced from pollack flesh emulsion, the first limiting factor is sulphur or aromatic amino acids. This is due to the fact that tryptophan, the limiting amino acid of fish flesh, is not removed during the washing process and its content increases higher than that of the original unwashed fish flesh.

The taste and flavour of LFP vary with starting materials and type of digestion. They are related to the amounts and kinds of free amino acids.

Mineral content

The mineral content of LFP manufactured from whole fish is generally low as shown in Table 4; calcium and fluorine particularly are lower than in FPC. Hazardous elements such as arsenic and heavy metals are lower than, or at the same level as, the normal diet. If a product of low mineral content is required, the use of washed fish tissue and the adoption of electrodialysis in the manufacturing process are recommended.

Table 4

Mineral content of LFP Samples (mg%)

Starting Material	Ca	P	K	Na	Mg	Cl	F	As	Cu	Fe	Cd	Hg	Heavy metals
Whole mackerel	54	874	—	465	90	—	1.10	—	3.8	—	ND	0.035	—
Whole mackerel	72	920	—	1 006	116	—	0.14	—	1.3	—	ND	—	—
Whole pollack	165	1 035	1 496	1 142	167	1 523	—	0.15	t	tr	—	0.013	4.0 ^{a/}

— Not determined t Detected on spectrogram

ND Not detected tr Trace on spectrogram

a/ Hazardous heavy metals except Cu, Fe were not detected on spectrogram

APPLICATION

Addition to food

As LFP is composed of peptides of various molecular weight, the addition of LFP produces an effect on the physical properties of a food. For example, the jelly strength of fish jelly products (kamaboko) is reduced by the addition of more than 3 percent LFP. In this case, the effect is more marked in LFP of higher molecular weight than in LFP of lower molecular weight. When 10 percent of LFP is added to baked foods, the texture of bread fermented with yeast is spoiled but the texture of buns made with baking powder is not changed.

The effect of LFP on taste and flavour was tested by preparing various dishes. Bitterness has the greatest influence on the taste; the effect of odour is not so noticeable. The effects are greater in the case of dishes prepared by long heating such as stew or borsch. Other undesirable effects such as reduced viscosity or increased tendency to scorch and stick are noticed in some dishes made by mixing LFP with wheat flour. The use of LFP without bitterness increased the acceptability of this product.

Medical applications

LFP is effective in maintaining plasma protein levels following stomach operations when patients are fed by tube. Other merits are a reduced tendency to diarrhoea and faster recovery after the operation.

As the taste of LFP is preferable to that of a compound diet containing a mixture of amino acids, patients accept LFP willingly when it is given orally.

As a protein source in milk replacer

A number of reports suggest that shortage of milk products in the near future will mean that skimmed milk can no longer be used as the sole source of protein in milk replacers (Jaubert, 1973). At present, various types of FPC are already used in milk replacers. However, LFP is superior to FPC in various properties such as solubility, nutritive value, low iron and mineral content, acceptability, etc.

One example of feeding experiments is shown in Tables 5 and 6. In this experiment, to examine the nutritive value of LFP, growth and digestibility tests were carried out by the use of pig tests of 5 days old, in which the secretion of digestive enzymes is insufficient.

According to these results, the growth of the group of animals fed on the milk replacer containing LFP was superior to the group fed on skimmed milk. The same tendency was observed in feed intake, feed demand and protein digestibility of pigs in the LFP group.

I . . .

Acceptability test for calves showed that the calves took the milk replacer containing LFP without any trouble.

I

Table 5

Composition of Milk Replacers (%)

	Group 1	Group 2
LFP from Alaska pollack	—	15
Skimmed milk powder	68	34
Lactose	—	19
Glucose	25.9	25.9
Soybean oil ^{a/}	5	5
Sodium chloride	0.3	0.3
Chromium oxide	0.1	0.1
Other ingredients ^{b/}	0.7	0.7
Total	100	100
Crude protein content	22.43	24.68

a/ 0.02% BHT was added to the oil to prevent oxidation of fats, vitamins, vitamins, etc.

b/ Antibiotics, trace elements, vitamins, etc.

Table 6

Growth of 5-day old piglets

Number of piglets ^{a/}		Body weight (kg)				Weight gain (kg)
		At the start	A week after	Two weeks after	Three weeks after ^{b/}	
Group 1	101	2.9	3.1	3.8	4.7	1.8
	102	3.5	4.0	5.0	6.1	2.6
	111	3.4	3.7	5.0	5.7	2.3
	112	3.7	4.0	5.3	6.4	2.7
	201	3.9	4.8	6.6	8.0	4.1
	211	2.6	3.6	4.3	5.4	2.8
	Average	3.33	3.87	5.00	6.05	2.72
Group 2	103	3.4	3.9	5.5	7.1	3.7
	113	3.3	4.2	5.7	6.9	3.6
	114	3.3	4.1	5.5	6.3	3.0
	115	3.6	4.5	6.3	7.4	3.8
	202	3.8	4.7	6.8	8.8	5.0
	212	2.5	3.0	4.4	5.7	3.2
	Average	3.32	4.07	5.70	7.03	3.72 ^{a/}

a/ Figure in the first place indicates the number of mother pigs; 0 and 1 in the second place, ♀ and ♂ respectively; and the figure in the third place, the number of piglets

b/ Body weight at 20th day after birth

RELATED LITERATURE

- Higashi, H., S. Murayama, T. Onishi, S. Iseki and T. Watanabe, Studies on liquefied fish protein. 1. *Bull-Tokai Reg.Fish.Res.Lab.*, (43):77-86 (in Japanese, English summary)
1965
- Iseki, S., T. Watanabe and T. Kinumaki, Studies on liquefied fish protein. 4. Examination of processing conditions for industrial production. *Bull.Tokai Reg.Fish.Res.Lab.*, (59):81-99 (in Japanese, English summary)
1968
- Jaubert, P., Marketing aspects of powdered products in the future. *In Fishery products*, edited by R. Kreuzer. West Byfleet, Surrey, Fishing News (Books) Ltd., for FAO, pp.391-4
1973
- Kinumaki, T., S. Iseki and H. Yuguchi, Studies on liquefied fish protein. 8. Amino acid composition of LFP made from different parts of fish body and washed meat. *Bull.Tokai Reg.Fish.Res.Lab.*, (77):55-68 (in Japanese, English summary)
1974
- Kinumaki, T. *et al.*, Studies on liquefied fish protein. 7. Mineral content of LFP made from whole fish and its removal by electrodialysis. *Bull-Tokai Reg.Fish.Res.Lab.*, (77):47-53 (in Japanese, English summary)
1974
- Kinumaki, T. *et al.*, New material based on liquefied fish protein. *In A comprehensive study on high technique to utilize protein and development of protein resources. Kenkyu Seika*, (89) (in Japanese)
1976
- Onishi, T. and H. Higashi, Studies on liquefied fish protein. 3. Odor and peptide composition of liquefied fish protein. *Bull.Tokai Reg.Fish.Res. Lab.*, (55):226-35 (in Japanese, English summary)
1968
- Sugii, K. and T. Kinumaki, Studies on liquefied fish protein. 6. Comparison of composition in different products by use of commercially available several proteolytic enzymes. *Bull.Tokai Reg.Fish.Res.Lab.*, (73):103-12 (in Japanese, English summary)
1973
- Yanase, M., Studies on liquefied fish protein. 2. Difference in tryptophan content in enzymatic hydrolysate of fish by different digestion methods. *Bull.Tokai Reg.Fish.Res.Lab.*, (43):87-90 (in Japanese, English summary)
1965

BY-PRODUCTS TECHNOLOGY AND WASTE UTILIZATION

by

S.O. Canonizado
Bureau of Fisheries and Aquatic Resource
Intramuros, Manila, Philippines

Abstract

Fishery by-products in the Philippines are largely derived from fish which cannot be sold. Production of fish paste, fish sauce and fish meal are the methods of waste utilization in the Philippines. The fish sauce and fish paste industries appear to be capable of standing on their own; they are firmly established and the product is indispensable in many households. The fishmeal industry is still in the process of growth and development. Fish silage on the other hand, is still at the research stage.

Although developments are taking place in fisheries by-product technology, the need for more hygienic, practical and efficient processes have to be considered.

INTRODUCTION

Economical and efficient utilization of fish can be achieved only when all the parts are utilized and no wastage is allowed in the industry. Fishery by-products are derived largely from the inedible portions of fish that constitute approximately 40-50 percent of the weight. Neglect of the potential of by-product utilization leads to serious forms of wastage. The proper utilization of by-products or their conversion into products of economic value will not only lead to the better utilization of resources but also result in lower-cost foods which can be a good source of proteins, vitamins and minerals. There are many methods of processing waste but the final choice will depend on the facilities and materials available, the cost of production and the demand for the product. In the Philippines, waste materials are used in the fishmeal, fish sauce and fish paste industries. Other industries which are slowly gaining attention are the production of leather from fish skins, production of fish liver oil, etc.

FISH PASTE

Characteristics

Fish paste or 'bagoong' is a semi-liquid product obtained from the liquefaction of a mixture of fish and salt. This is widely used as a condiment but is also used as a protein food for the poorer section of the population especially in places far from the sea where fresh fish is seldom available.

Raw materials for fish paste production are round scad (*Sardinella fimbriata*), herring (*Spiratelloides japonicus*), sardine (*Sardinella longiceps*), anchovy (*Stolephorus indicus*), small slipmouth (*Leiognathus*) and, for 'bagoong alamang', tiny shrimps are used. Most of the raw materials used are whole fish which cannot be sold and those which can no longer be sold as fresh fish. Fish offal can also be used.

Process

The method of preparation involves the mixing of fish and salt in the proportion 1:3 or 2:7 (by weight). Bacterial growth is arrested and during fermentation, the fish proteins are broken down into their soluble constituents, chiefly amino acids; hydrolysis is mainly the result of enzymatic action.

Factors affecting quality

Several studies have been conducted on improving the quality of fish paste. Salt purity has been found to play an important role in the rate of fermentation. Impurities present in salt such as magnesium and calcium have been found to retard penetration of salt into the fish. Fish hydrolysis is said to be the result of enzymatic action and therefore the possibility of increasing the rate of fermentation by the addition of enzyme preparations was investigated by Guevara *et al.* (1973). The enzyme used was papain obtained from the latex of papaya, *Carica papaya* Linne. Within the range of concentrations of 0.1-0.5 percent, the rate of fermentation increased with increasing enzyme concentration as shown by the amount of crude protein of the liquid portion of bagoong made from anchovy. The effect of high temperatures (37.5°-55°C) was also studied. Hydrolysis was faster at higher temperatures especially at 45°C. At 55°C however, the rate of fermentation was not accelerated and led to a cooked flavour.

FISH SAUCE

Product description

The clear, straw-yellow to amber coloured liquid that can be drawn off from the liquefaction of a fish-salt mixture is called fish sauce or 'patis'. This is widely used in the Philippines for salting and seasoning food. According to the Food and Drug Administration (1977), fish sauce should meet the following standards of quality:

Specific gravity — 1.20-1.23

Total solids — not less than 32 percent

Salt content — 20-25 percent as sodium chloride

Protein content — depends on the brand:

 Fish sauce for domestic trade

 special — not less than 8 percent

 regular — not less than 4.5 percent

 flavour — 4.5 percent but not below 2.5 percent

 fish sauce for export

 special — not less than 8 percent

 regular — not less than 6 percent

Methods of manufacture

The process of manufacture for fish sauce involves the following basic steps:

- (a) Sorting: raw materials are inspected and seaweed and other foreign material are removed;
- (b) Mixing: salt is added to the fish in the proportion 1:3 or 2:7 (by weight). They are then mixed thoroughly either by hand or by the use of a shovel;
- (c) Packing and storage: the fish-salt mixture is packed in wooden vats, earthenware jars or concrete tanks and temporarily stored for fermentation;

- (d) Fermentation: takes about six months to one year;
- (e) Extraction: the filtrate is collected by gravity from the fermenting vats through a spigot near the bottom of the container. This is usually carried out from the highest grade to the lowest grade. The residue after the first and second filtrate extraction serves as fish paste or 'bagoong' while the residue left after the last extract is used as fish meal. Recent laboratory tests have shown the value of the final residue as fertilizer;
- (f) Filtration: separation of clear filtrate by utilizing clean cotton or cheese cloth.

Present situation in the industry

A survey of the fish sauce industry in Manila, covering 34 establishments, was conducted by Tesoro (1969). The results indicated the following practices:

- (1) A combination of different species of fish is used by 53 percent of the respondents. This practice has an effect on the flavour of fish sauce because sauce from the small fish will be fully aged before the larger fish disintegrate;
- (2) Enzymes are known to shorten the curing period of fish and salt mixture but none of the respondents uses any;
- (3) One hundred percent of the establishments use native salt (92 percent NaCl) because of the high cost of the refined salt (99.9 percent NaCl);
- (4) Thirty percent of the respondents ferment for eight months, 20 percent for twelve months, 17 percent for nine months, 10 percent for seven months, 7 percent for ten months and 16 percent did not give any answer. Aging was accelerated by using solar energy by 50 percent of the respondents;
- (5) Sixty percent make use of artificial colour while 37 percent do not; 3 percent gave no answer. The most common artificial colour used was caramel and a chemical compound sold under the brand name CIBA;
- (6) Seventy percent do not sterilize their products while 30 percent gave no answer;
- (7) Only two establishments out of the 34 surveyed use sodium benzoate to prolong the keeping quality of the sauce.

Abulon (1971) has classified the methods of manufacturing fish sauce in 58 establishments in the Malabon and Navotas regions:

- (a) Traditional class: establishments adopting the traditional process in the manufacture with the use of some traditional equipment (50 percent).
- (b) Medium class: establishments utilizing some traditional equipment coupled with some improved techniques (48.4 percent).
- (c) Mechanized class: manufacture by automated machines and modern techniques (1.6 percent).

Production by mechanized methods is high, 9 million litres, compared with about 3.5 million for the medium class and 40 000 for the traditional producers.

Potential of the industry

It appears that the fermentation industry (fish sauce and fish paste) is capable of taking care of itself; the larger establishments have a good industrial level and the product is indispensable in Philippine households both at home and abroad. The Market Research Unit within the National Food and Agricultural Council has

included consumption of fish sauce and fish paste in two of their surveys in 1970 and 1971. The results have indicated a yearly consumption of about 100 000 tonnes. The Bureau of Fisheries and Aquatic Resources has sent questionnaires to fish processing firms which indicate an annual production corresponding to not less than 100.000 tonnes of fresh fish.

Exports of fish sauce has been increasing, from 44 836 kg in 1974 to 388 073 kg in 1975 (BFAR Statistics, 1975). Importing countries include Canada, Denmark, Hong Kong, Japan, Malaysia, Trust Territory, U.S.A. (including Hawaii) Guam and other countries (see Table 1). The possibilities of creating other export markets should not be neglected.

Table 1

Export of fish sauce by quantity and value, 1974-75 a/

1974		1975	
Quantity (kg)	Value (P.Ps.)	Quantity (kg)	Value (P.Ps.)
44 836	274 151	388 073	1 812 599

a/ Source: Bureau of Fisheries and Aquatic Resources,

Problems facing the industry

Problems recorded relate to variations in the quality of the finished product brought about by the use of different species of fish as raw material and the marketing of inferior fish. There is the need for standardization of specifications and a central system for quality and hygiene (Norconsult, 1975). There is also the problem of fat floating on the surface of the liquid sauce.

FISH MEAL

Product description

Fish meal is a dried product, ground to small particle size, with no other ingredients added and processed with or without the extraction of part of the oil. It is an important additive in ready mixed poultry and pig feed. The characteristics which make fish meal a valuable feed supplement have been specified by the Bureau of Animal Industry Administrative Order No. 40 requiring a good fish meal to contain not less than 45 percent protein and not more than 7 percent salt, with the absence of pathogenic bacteria. In addition, fish meal has to have a high digestible protein content, low level of fibre and high content of mineral and accessory growth factors. Fish meal can be made from fish waste (consisting of the head, tail, fins and viscera), scrap and fish that do not command a good price in the market and dried fish that is not saleable on the consumer market for quality reasons.

Methods of production

Local fishmeal processors vary in their methods of production. There are however, two general methods for the production of fish meal, namely: dry reduction and wet reduction.

Dry reduction

The raw material is first ground, then dried and finally packaged. For drying the material is placed in circular drums which are heated with steam until the final moisture content is about 12 percent; this takes about six hours. Sun-dried fish, which have a moisture content of 18-25 percent are in heated flat bed bin driers at about 90°C for about three hours until the moisture content decreases to about 10 percent. Drying can also be achieved naturally by using solar energy. The cooked dried fish is fed into a hammer mill where it is pulverized before packing.

Wet reduction

The raw material is cooked and pressed, the liquid portion is removed and the residue is placed into the driers. Dried fish are hammer-milled and packaged in polypropylene sacks. This second method is not common in the Philippines because oil extraction equipment is not available.

Present status of the industry

Present production of fish meal in the Philippines is based mainly on waste, rejects and market surpluses. Most of the fishmeal processors use the dry reduction process but many of them have made improvements with regard to the reduction of bacterial load, odour and particle size. Bacterial load is reduced by fumigation in the drying process. Due to the varieties of raw materials used, some processors use a mixer to improve quality by producing a homogeneous product. As far as it is known only one fishmeal plant in the Philippines has oil extraction equipment (Norconsult, 1975).

Potential of the industry

The Philippine fishmeal industry has a very good potential because of the increasing demand for meal as a feed ingredient (see Tables 2 and 3). Domestic production of fish meal reached around 12 000 tonnes/y in 1972 and 1973. Since only about 15-20 percent of the demand is satisfied, national production of fish meal is supplemented by imports of 10-20 thousand tonnes/y (see Table 4). Imports represent an appreciable and constant drain on the foreign currency balance. However, imports have fluctuated considerably due to the practice of adjusting feed blend formulas.

Pricing

Pricing plays a very important role in the fishmeal industry. If local fish meal of about 60 percent protein and 10 percent moisture is sold at P.Ps. 3.90/kg^a, the fresh fish should be purchased at P.Ps. 0.75/kg, which is extremely low (Lugtu, 1977). When fresh fish purchased at P.Ps. 0.75/kg is dried to about 33 percent, the cost increases to approximately P.Ps. 2.25. An additional P.Ps. 0.35 for labour and transportation costs will lead to a price of P.Ps. 2.60/kg. Further processing will reduce the moisture content up to 15 percent increasing the price to P.Ps. 3.10/kg. The processing cost, depreciation of equipment, cost of packaging, financing and return of investments bring the price of local fish meal to about P.Ps. 3.90/kg. The cost of imported fish meal may range from P.Ps. 4.80 to 5.20.

a/ P.Ps. 1 = U.S.\$ 0.13 (April 1978)

Table 2

Fish meal demand and consumption 1964-73 (in tonnes)

Year	Consumption	Calculated demand
1973	14 900	27 900
1972	25 000	26 300
1971	17 700	25 200
1970	18 400	23 900
1969	19 200	24 400
1968	21 400	24 800
1967	13 100	22 700
1966	8 810	22 800
1965	9 500	17 300
1964	9 700	15 600

Table 3

Projections of consumption of and demand for fish meal (in tonnes) ^{a/}

Year	Projected consumption	Nutritional demand
1975	18 800	33 300
1980	33 800	51 700
1985	60 800	80 300

^{a/} Source : Margubat, 1974

Table 4

Import data on fish meal, 1971-75 ^{a/}

Year	Quantity (kg)	Value (P.Ps.)
1971	10 134 158	10 142 424
1972	11 602 247	12 141 199
1973	1 322 345	2 634 410
1974	8 347 155	18 655 451
1975	28 707 283	54 517 213

^{a/} Source: BFAR, 1975

Problems facing the industry

- (1) Shortage of raw materials: Fishmeal operations cannot obtain a reasonably priced supply of fish for the following reasons:
 - (a) Lack of awareness in the main fishing sectors of the country about the viability of supplying fresh or dried fish to fishmeal processors. Most of the trash fish that could be used for fish meal are channelled instead to the fish paste and fish sauce manufacturers where there is greater profitability. As a result, much of the current supply is managed through middlemen; this leads to higher prices.
 - (b) Lack of an established system for the supply of fish. The proportion of fish that is converted to fish meal is very small because Filipinos are a fish-eating people. At present, fishing boat operators give higher priority to the supply of fish for human consumption.
 - (c) There is still a need for more efficient fishing techniques and equipment although efforts are being made by the Government, through the Bureau of Fisheries and Aquatic Resources and other research institutions, to increase the fish catch.
 - (d) The fishermen are unaware of the value of unpopular species of fish; although not acceptable for human consumption, this could be a potential source of raw material for fish meal.
 - (e) Seasonal nature of fishing.
- (2) Lack of equipment such as that used for oil extraction: this would help lift the economic status of the fishmeal industry.
- (3) Pricing difficulties: Unstable pricing for raw materials and virtually inflexible acquisition-price structure from users (Lugtu, 1977). It must be noted that fishmeal pricing depends on its quality, in terms of nutritive value.
- (4) Variable standards: There is a need for more strict enforcement of quality control in the industry. Efforts, however, are being made by the Bureau of Animal Industry to enforce quality control. Producers who add copra meal, feather meal or corn gluten to the fish meal are ordered to close temporarily. Operators also lack sufficient knowledge of the theoretical, practical and economic aspects of fishmeal production.
- (5) Uncertain future: If the fishmeal industry cannot supply the needs of feed mills, it will face an unstable future (Lugtu, 1977). This has happened in the past when some manufacturers have set up facilities to fill the need which is now supplied by massive fish meal imports.

FISH SILAGE

Prospects for fish silage

Fish silage is a new development in the production of animal feeds. However, in the Philippines this product is still at the research stage. The use of fish silage in the Philippines has been studied; Flores (1974) mentioned that fish silage production is possible in Philippine conditions since there are waste materials from

canneries. However, for this industry to flourish, there is still the need for more raw materials. The importance of this product will have to be studied further.

REFERENCES

- Abulon, V., The manufacture of fish sauce in the Philippines. University of the Philippines Training Program
1974 in Development Economics (unpub.)
- Flores, F.A., The nutritive value of fish silage compared with fish meal (*Chanos chanos* Forskal). B.S. Fisheries
1974 Thesis. University of the Philippines, College of Fisheries (unpub.)
- Guevara, G., V.C. Matias and P. de la Pena, Fish fermentation with the use of papain. *In* Proceedings of the
1973 Eight Annual Convention, PAFT. Manila, pp. 103-7
- James, A., Ensiled product from fish by microbial fermentation. *Fish. Technol.*, 3(1):38-43
1966
- Lugtu, R., The local fishmeal industries: an overview. Paper presented at the Seminar on Fishmeal Products
1977 and Marketing, Quezon City, Manila
- Mangubat, M., The economic feasibility of developing the local fish meal industry. Seminar paper. University
1974 of the Philippines Training Program in Development Economics (unpub.)
- March, B.E., Fish meal and condensed fish solubles in poultry and livestock feeding (Borgstrom, G.) *Fish as*
1962 *Food*, Vol. II, New York and London, Academic Press
- Norconsult, S., Philippine fish marketing and distribution study. Vol. 6. Fish processing industries. Manila,
1975 Bureau of Fisheries and Aquatic Resources
- Philippines Bureau of Fisheries and Aquatic Resources, Fisheries statistics. Manila, Bureau of Fisheries
1975
- Tesoro, L., A study of the patis industry in Manila and its environs. Thesis. University of the Philippines,
1969 College of Home Economics (unpub.)
- U.S. Food and Drug Administration, Administrative Order No. 325 s. Definition and standard for foods, condi-
1977 ments, sauces and seasonings standard of identity and quality for patis. Washington, D.C. U.S.
Food and Drug Administration

FISHERY BY-PRODUCTS AND UTILIZATION OF FISHERY WASTES IN INDIA

by

P.V. Prabhu, P. Madhavan and K.G. Ramachandran Nair
Central Institute of Fisheries Technology
Cochin-682003, India

Abstract

Traditional fishery by-products such as fish meal, fish liver oil, shark fins and fish maws are produced commercially in India for domestic consumption and for export. However, an organized attempt to modernize the industry and to vary the products utilizing the cheap varieties of fish (prawn by-catch) and other fish waste is required. The present status of this diversification is reviewed.

INTRODUCTION

Rapid strides have been made by the fishing and fish processing industry in India during the past two decades with the result that the fish landing has doubled and the export of processed fishery products has risen by 300 percent. However, the modern fish processing industry is based mainly on prawns which constitute only 10-12 percent of the marine catch. Considerable progress has been achieved in the freezing of prawns and the country now has 217 freezing plants with a total capacity of 1,000 tonnes per day. This has necessitated the introduction of more cold stores and there are now 273 cold stores with a total capacity of 21,558 tonnes. Fish canning had also shown rapid progress in the early sixties but has since declined and at present only a small percentage of the total catch is canned. Much of the fish is utilized fresh but a good percentage is used for salting and curing. Fishery by-products also have an important place in the fishing industry.

PRESENT STATUS OF FISHERY BY-PRODUCTS

India produces traditional fishery by-products such as fish meal, fish liver oil, fish fins, fish maws and fish body oil.

Fish meal

About 10 percent of the fish landings are converted into fish meal. With the increase in fish landings, the production of fish meal has also increased considerably. The miscellaneous fish caught along with prawns during trawling, form the major source of raw material for fish meal. They include small jewfish, sole, silverbellies, ribbonfish and the like. Traditional fish meal production used sundried fish collected from various drying centres along the coast and the product was chiefly used as manure. The better quality fish meal has been a prominent item of export from the very beginning of the industry. Improving the quality of fish meal is important and, in 1959, the Ministry of Food and Agriculture laid down specifications regarding the quality of fish meal. Later, the Indian Standards Institution brought out the Indian Standard Specifications (IS:4307-1967) for fish meal. In recent years the fishmeal industry has shown signs of fast progress. In 1972 there were seven modern fishmeal plants in the country, with an installed input capacity of 175 tonnes per day (Medhavan *et al.*, 1974). A few more plants have been installed during the past 4 years.

Fish oil industry

Sharks constitute a considerable proportion of the fish catch in India. The liver oil of these sharks is rich in vitamin A. Apart from a few well organized factories producing shark liver oil of pharmaceutical quality, there are a number of small extraction units located at several fishing villages. The crude oil extracted in small units is refined and diluted for the production of IP grade vitamin A formulation in bigger factories.

Oil sardine makes up about 30 percent of the marine catch of India. The peak season for the fishery is from October to January when the oil content of the fish is also at a maximum rising to 17 percent. The traditional method of extracting the oil from the fish was practised as a cottage industry, in the fishing villages along the southwest coast. The quality of oil extracted was poor primarily because of the high free fatty acid content and the presence of foreign matter and could be used only for painting country fishing craft. Recently, attempts have been made to produce the oil under controlled conditions employing modern extraction units in fishmeal plants. As a result, oil of consistent quality (about 1,500 tonnes) is now available for better utilization.

Shark fins and fish maws

The total production of dried shark fins and fish maws is exported to countries such as Hong Kong, Singapore, Malaysia and the United Kingdom, where they form the raw material for the production of fin rays, glues, isinglass and gelatine.

Prawn waste

Since the the major portion of prawns landed are processed into the frozen or canned form, large quantities of head and shell waste are now available from the processing plants. The general means of disposal was to throw the waste into backwaters or partly utilize it as manure. A good percentage is now sun-dried and powdered and used either as manure or in poultry feed formulations. Prawn shell powder generally contains only about 35 percent protein and as such is not classed along with fish meal.

SCOPE FOR FURTHER DEVELOPMENT

With the expected increase in fish landings as a result of the exploitation of the extended 200 mi economic zone, there is considerable scope for expanding the by-products industry in the country. Inland fish production is also increasing rapidly with the improved techniques of cultivating fish in reservoirs, ponds and sewage waters. Investigations being conducted in various research institutes on fish processing and utilization have shown promising results for the development of fishery by-products as well as speciality products from fish waste and prawn by-catch.

Fish meal

About a dozen modern fishmeal plants at various fishery centres do not operate at full capacity although they produce considerable quantities of fish meal. As the fish landings are scattered along the coast, the prospects of installing fishmeal plants of large capacity are not good. Prospects for fishmeal manufacture can be improved by the introduction of comparatively small plants in the fishing villages. A batch-type rotary drum drier for the production of fish meal from whole lean fish or press cake from fish body oil extraction plants has been successfully demonstrated by Chakraborty *et al.* (1970). Designs of plants which can be made locally are obtainable from the Central Institute of Fisheries Technology.

The progress being made in the field of poultry farming can be maintained and further accelerated only by increasing the production of fish meal which forms an important ingredient in the feed for livestock. The world requirement for fish meal is also increasing and India can expect to partly cater to this need by stepping up fishmeal exports. The expected increase in fish landings and the increasing demand in both internal and overseas markets promise a very bright future for the industry.

Fish oil

Production of fish oil has achieved considerable improvement both in quality and quantity in recent times due to the establishment of modern fishmeal plants. Extensive work on sardine oil has been carried out at the Central Institute of Fisheries Technology (CIFT) (Kamasastri, 1960; Kamasastri *et al.*, 1962), the Central Food Technological Research Institute (CFTRI) (Sen and Revankar, 1973) and other prominent research organizations in the country. Many industrial uses for good quality sardine oil have been established. It has been shown that the oil is rich in polyunsaturated long chain fatty acids (Gopakumar and Rajendranathan Nair, 1966).

The work carried out on the industrial uses of sardine oil, such as in the paint and allied industries (Anon., 1968) shows a great potential for sardine oil. Although wide fluctuations occur in the landing of oil sardine, a steady and abundant supply can be predicted with the exploitation of the pelagic fishery resources by the introduction of purse seines and the other suitable gear (Devidas Menon, 1971). Even if a good percentage of the catch goes for fresh consumption owing to the improvements effected in the transportation of fresh fish, increasing quantities are also expected to be available for processing into fish meal and fish oil.

Shark skins and fins

Dried shark fins are now exported as raw material for making fin rays, glue, etc. The fins can be processed into these products within the country; the method for extracting fin rays has been worked out by CIFT (Ramachandran Nair and Madhavan, 1974) and has been taken up by the industry. Fish glue can also be prepared from the fins after extracting the rays.

It has been calculated that about 200,000 m² of shark skin can be manufactured in the country. Presently, shark skin is not used but the CIFT and the Central Leather Research Institute have shown that the skin can be flayed and processed into superior quality leather (Venkataraman and Prabhu, 1964). There are excellent prospects for developing the shark skin and fin ray industry which will help to provide employment to rural people and utilize profitably materials which now go to waste.

Fish maws

Fish maws can be processed into isinglass and gelatine. The expansion of fishing into the 200 mi economic zone will result in the increased landing of fish from which air bladders will be available for developing this industry. The technological aspects have been studied by the various research institutes and the results of the studies can be implemented by industry.

Utilization of prawn waste

It is estimated that 45,000-50,000 tonnes of prawn head and shell waste are now available from the prawn freezing and canning industry and attempts have been made by the research organizations to produce products which have either a food value or are of industrial importance. The work done at the CIFT in this field is worth

mentioning. Methods have been worked out for the extraction of protein and chitin and for the conversion of the chitin into chitosan (Radhakrishnan and Prabhu, 1971; Madhavan and Ramachandran Nair, 1974; Ramachandran Nair and Madhavan, 1975; Moorjani *et al.*, 1975). Extensive work has also been carried out on the industrial application of chitosan (Prabhu *et al.*, 1976; Madhavan and Ramachandran Nair, 1977).

Methods for the production of yet another industrially important product, glucosamine hydrochloride, from prawn waste have been developed by CIFT and the National Chemical Laboratory, Poona (Kamasastri and Prabhu, 1961; Ingle *et al.*, 1973).

The chances of starting new industries to process prawn waste and squilla are enhanced by this research as well as by the needs of the prawn processing industry to generate income from the waste.

Squilla (*orato squilla nepa*) which forms a considerable portion of the trawler catch is also a rich source of chitin (Madhavan and Ramachandran Nair, 1975). A method for separating the protein from squilla has been reported (Lekshmi Nayar and Prabhu, 1977).

There are immense possibilities for utilizing the trawler by-catch for the production of a number of diversified products, processes for which have been developed in various research laboratories. However, an organized attempt is called for to exploit these processes commercially and expand the industry.

REFERENCES

Anon., Paint India, 18, p. 4
1968

Chakraborty, P.K., S. Ayyappan Pillai and K.K. Balachandran, *Fish. Technol.*, 7(2):164
1970

Devidas Menon, M., *Seafood Export Journal*, 3(12):7
1971

Gopakumar, K. and M. Rajendranathan Nair, *Fish. Technol.*, 3(1):21
1966

Ingle T.R., S.H. Vaidya and M.V. Pai, *Res.and Ind.*, 18(2):54
1973

Kamasastri, P.V., *Ind.J.Fish.*, 7(2):443
1960

Kamasastri, P.V. and P.V. Prabhu, *J.Sci.and Res.*, 20D(12):466
1961

Kamasastri, P.V., P.V. Prabhu and D. Ramanada Rao,, *Ind.J.Fish.*, 9(2):108
1962

Lekshmi Nayar, A. and P.V. Prabhu, *Fish. Technol.*, 14(1):53
1977

Madhavan, P. and K.G. Ramachandran Nair, *Fish. Technol.*, 11(1):50
1974

_____, *Fish. Technol.*, 12(1):81
1975

_____, Paper presented at the 1st International Conference on chitin/chitosan, Boston, Mass., U.S.A.
1977

Madhavan, P., T.S. Unnikrishnan and K.K. Balachandran,, *Fish. Technol.*, 11(2):102
1974

Moorjani, M.N., V. Achutha and D. Impon Khasin, *J. Food Sci. Technol.*, 12(4):187
1975

Prabhu, P.V., A.G. Radhakrishnan and T.S. Gopalakrishna Iyer, *Fish. Technol.*, 13(1):69
1976

Radhakrishnan, A.G. and P.V. Prabhu, *Res. and Ind.*, 16(4):265
1974

Ramachandran Nair, K.G. and P. Madhavan,, *Fish. Technol.*, 11(1):60
1974

_____, Paper presented at the Symposium on Fish Processing Industry in India, Mysore
1975

Sen, D.P. and G.D. Revankar, *Ind. Food Pack.*, 27(3):20
1973

Venkataraman, R. and P.V. Prabhu, Paper presented at Tanner's Conference, Rajkot
1964

PEPTON FROM THREADFIN BREAM (*NEMIPTERUS JAPONICUS* BLOCK):
PREPARATION AND SUITABILITY AS MICROBIOLOGICAL GROWTH MEDIA

by

K. Mahadeva Iyer, K. Gopakumar, A. Vasanth Shenoy,
M. Arul James and M.R. Nair
Central Institute of Fisheries Technology
Cochin-682003, India

Abstract

Pepton samples were prepared from threadfin bream (*Nemipterus japonicus*), using both whole fish and mince with and without defatting. The samples were evaluated for their ability to support microbial growth by measuring the optical densities of the growth suspension as well as total cell mass produced in broths incorporating the peptones. A 0.5 to 1.0 percent solution of the peptones compared favourably with that of Difco peptone taken as standard. Terrestrial as well as marine bacteria were employed as test organisms.

INTRODUCTION

The use of hydrolysates derived from fish flesh as a source of nutrient compounds for the growth of certain anaerobic bacteria was demonstrated by Tarr and Deas (1949). Since then a number of workers have turned their attention to the preparation of fish hydrolysates for use in foods and feeds (Hale, 1972; Mackie, 1974; Meinke and Mattil, 1973; Spinelli *et al.*, 1972a and 1972b). On the use of these hydrolysates as microbiological growth media, Snieszko *et al.*, (1950) showed that fish peptone was found to be an ideal enrichment component for a fish pathogen. Malushko (1966) found that media prepared from fish hydrolysates could be used for the cultivation of rodent typhoid bacteria. Green *et al.* (1973) compared fish peptones to commercial peptones with respect to their ability to support microbial growth when incorporated into microbiological growth media. Apart from fish peptones, salmon canning waste water was found to support growth of bacteria both as a complete medium and as a supplementary nitrogen source (Strasidine and Melville, 1972). In Australia (Anon., 1973) a beef extract-like product has been prepared, using the cooker juices from the pre-cooking of canned tuna and from the stickwater produced during the preparation of fishmeal. These products indicate the potential for an aqueous extract of certain fish as a source of nutrients for bacterial growth.

Beuchat (1974) showed that catfish peptone compared favourably with certain commercially available growth media for supporting the growth of both bacteria and fungi. Recently, Stephens *et al.*, (1976) have described the preparation of peptones from raw shrimp waste after autolytic digestion. They found that the shrimp head digest supported excellent growth of fungi and good growth of bacteria. Green *et al.* (1977) have examined the stability of two soluble heat-stable fish peptones derived from red hake (*Urophycis chuss*) and Atlantic menhaden (*Brevoortia tyrannus*) and explored their use as peptone constituents of microbiological media. They equated their performance with those of commercially available peptones and beef extract.

The annual landing of fish for commercial utilization in India is about 0.8 million tonnes. Out of this 0.44 million tonnes are less utilized varieties and *Nemipterus japonicus* accounts for 3,000 tonnes.

A series of trials conducted with several species, considered as poorly utilized varieties, showed that *Nemipterus japonicus* could form a good raw material for the preparation of peptone because of its low fat content and its excellent susceptibility to enzymatic hydrolysis. This paper describes the procedures chosen for the preparation of peptones from different forms of raw material, i.e., whole fish, deboned fishmeat and deboned, defatted fishmeat. The performances of the peptones were compared to a well-known commercial brand, Difco. Their potential use as a component in microbiological growth media is discussed.

MATERIALS AND METHODS

The raw material used for the preparation of the peptone was treated as follows:

- (1) Whole fish, comminuted in a mechanical meat mincer, was used for the preparation of peptone A;
- (2) Fish flesh, prepared using a mechanical meat/bone separator, was used for the preparation of peptone B;
- (3) The minced meat prepared as in (2) was cooked and extracted with acetone to remove fat. The extraction was continued until the acetone was colourless. This defatted meat formed the source for peptone C.

Hydrolysis

The three types of fishmeat were separately subjected to enzymatic hydrolysis using commercial grade papain. The meat was mixed with water (1:1/w/v) into a fine slurry which was sterilized at 10 lb/in² pressure for one hour. The contents were allowed to cool and papain solution in distilled water was added. The concentration of enzyme was in the ratio 1:30 (enzyme nitrogen to protein nitrogen). The reaction was carried out at a temperature of 50°C and at pH 6.5. The whole mixture was continuously stirred mechanically. The hydrolysis was allowed to continue for 10 hours. The reaction was then stopped by boiling the whole hydrolysate, after which it was filtered through Whatman filter paper. Centrifugation of the filtrate was found to be efficient for the removal of any fat present in the hydrolysate. The top layer containing fat was removed using a separating funnel. The filtrate was concentrated under vacuum and the concentrated hydrolysate dried in a freeze drier. The dried peptone was packed in air-tight amber coloured bottles.

Analysis of peptones

All three peptones were analysed for crude protein, ash and fat content (AOAC, 1975) and were compared to Difco peptone and catfish peptone.

Evaluation of the peptone as a microbiological growth media

The peptones dissolved readily in both distilled water and seawater (at 0.5 percent) to form a clear solution. Solution in seawater was employed for bacteria isolated from a marine fish source. The peptones were compared with the Difco peptone for their capacity to support growth of bacteria. This was determined by measuring the biomass production in each medium using four genera of bacteria (terrestrial, including two pathogens) four unidentified cultures of gram-negative rods (isolated from fresh sardines) and four fungal genera. The terrestrial bacteria were *Salmonella anatum*, *Staphylococcus aureus*, *Bacillus cereus* and *Escherichia coli*. The fungi employed in the study were *Saccharomyces cerevisiae*, *Candida lipolyticus*, *Neurospora crassa* and *Rhizopus niger*.

Growth media for the terrestrial bacteria were compounded to contain 0.5 percent of the peptone (w/v) and 0.5 sodium chloride (w/v). The pH of the medium was adjusted to 7.2. The media intended for marine organisms consisted of 0.5 percent peptone dissolved in aged seawater. Formulation of media for fungal growth was similar to that used for terrestrial bacteria except for the addition of one percent glucose with the pH adjusted to 6.0. The liquid media were dispensed as 50 ml aliquots in 100 ml Ehrlenmeyer flasks and autoclaved at 121°C for 15 minutes.

Each of the terrestrial bacteria was grown in nutrient broth for 24 hours at 37°C. The marine organisms were cultured in seawater peptone (0.5 percent Difco peptone in aged seawater containing a trace of ferric phosphate) for 24 hours at room temperature (28°C ± 1°C).

Fungi were cultured in Sabourauds' Dextrose agar for 5 days at room temperature (28°C ± 1°C). The surface of the cultures was then washed with 5 ml of normal saline to collect the spore/mycelium as inoculum for the experiment.

Inoculation of the test media

The 24-hour broth cultures of the bacteria (both terrestrial and marine) were diluted ten-fold in normal saline and a 1 ml aliquot of the diluted culture was added to 50 ml of the test broth. Cultures were incubated for 24 hours at 37°C in the case of terrestrial organisms and room temperature (28°C ± 1°C) in the case of marine bacteria. To the fungal media 0.1 ml of the spore/mycelium washing was added and incubated at room temperature (28°C ± 1°C) for 48 hours. In all cases, further growth was arrested by autoclaving at 4.54 mg for 15 minutes after the stipulated incubation period of 24 hours for bacterial cultures and 48 hours for fungal cultures.

The cells were collected by centrifugation at 17,000 x g for 15 minutes. The pellet of bacterial biomass was washed once with normal saline and collected again. The pellets were transferred to tared aluminium pans and dried in an air oven at 65°C for 24 hours and then weighed. Biomass production was estimated as milligrammes of cells per 100 ml of the original test medium.

Fungal mats were collected by filtration (Am.Pub.Health Ass., 1971), washed with sterile water and dried in a hot air oven at 65°C for 24 hours. *Saccharomyces cerevisiae* cells were collected by centrifugation as with the bacterial cells. The weight of cells (in milligrammes) per 100 ml of original test medium was estimated as biomass production.

In the case of the marine bacterial cultures, optical densities of the growth suspension were also determined in addition to biomass estimation. A 6 ml aliquot of the culture suspension was removed from a 24-hour growth suspension using a sterile pipette and the percentage transmission measured using an Evelyn colorimeter. After measurement, the aliquot Ehrlenmeyer flask which was then autoclaved to arrest further growth prior to biomass determination.

Using peptone media, prepared as described above but containing 1.5 percent agar, surface plating of 24-hour old cultures was carried out to observe bacterial colony size, morphology and pigmentation after incubation for 48 hours at room temperature (28°C ± 1°C).

RESULTS AND DISCUSSION

The crude protein content of peptone samples A, B and C was somewhat lower than that reported for Difco peptone and the fat content of all three test peptones was lower than that of Difco and catfish peptone (see Table

1). Stephens *et al.* (1976) reported that the peptones prepared from digested shrimp heads and digested shrimp hulls contained respectively 2.7 percent and 1.4 percent fat. With respect to our samples, the fat content was only 0.13 percent for peptone A, 0.1 percent for peptone B and negligible for peptone C. This low fat content was advantageous as it prolonged the keeping quality of the samples as well as enhanced the bacterial growth. Since peptone A contained only 0.13 percent fat, the defatting procedure could be omitted. The ash content of the samples ranged from 5.97 to 10 percent (see Table 1); although these values were higher than the values reported for Difco peptone, no adverse effects were found on the growth of the bacteria and fungi tested. This finding agrees with that of Beuchat (1974) who reported a fat content of 10 percent for his catfish peptone.

Table 1

Proximate composition of the laboratory-prepared peptones and reference peptones

Component	Peptone A	Peptone B	Peptone C	Difco ^{a/} peptone	Catfish ^{a/} peptone
Crude protein % ^{b/}	84.60	83.50	77.62	94.70	80.02
Fat %	0.13	0.10	negligible	0.06	0.44
Ash %	10.00	7.00	5.97	5.91	10.42

a/ from Beuchat (1974)

b/ Kjeldahl nitrogen x 6.25

The weight of the biomass produced by all organisms in each medium was considered for evaluation of the peptone (see Table 2). The results showed that peptone C supported the maximum bacterial growth. Peptone A and peptone B were ranked second and third respectively. With fungal cultures, the performances were more or less equal with peptone C and peptone A, followed by Difco peptone and peptone B in that order (see Table 2). On the whole, peptone C gave the best performance. Bacterial colony size and other morphological features, like nature of margin, elevation of colonies and pigmentation on solid agar media containing different peptones, were found to be almost similar.

In the case of marine bacteria the optical density (OD) of the growth suspension in different media was also determined. Table 3 shows that a correlation existed between OD and biomass; a general increase in the values of OD was observed with increase in biomass production. Taking the averages of OD values given by all organisms in each medium, peptone C could be ranked first in performance.

Table 2

Biomass production (mg dryweight)

Test organisms	Biomass produced ^{a/}			
	Peptone A	Peptone B	Peptone C	Difco Peptone
<i>Bacteria</i> (terrestrial)				
<i>Staphylococcus aureus</i>	14.8	12.0	19.2	10.0
<i>Salmonella anatum</i>	16.0	20.0	16.0	7.6
<i>Bacillus cereus</i>	14.4	10.8	25.2	10.0
<i>Escherichia coli</i>	12.4	4.4	16.8	6.6
Average	14.4	11.8	19.3	8.55
<i>Bacteria</i> (marine)				
SMB - 10	18.4	14.4	2.8	9.2
SMB - 12	9.6	8.4	7.6	19.6
SMB - 14	52.8	36.4	78.4	21.2
SMB - 17	34.4	27.6	63.6	26.0
Average	28.8	21.7	38.1	19.0
<i>Fungi</i>				
<i>Saccharomyces cerevisiae</i>	36.0	23.6	28.4	76.0
<i>Candida lipolytica</i>	84.4	77.2	69.2	74.2
<i>Neurospora crassa</i>	35.2	20.8	22.8	34.8
<i>Rhizopus niger</i>	18.8	23.6	52.0	30.4
Average	43.6	36.3	43.1	40.9
Average for all micro-organisms	29	23.3	33.5	22.8
Media rank	2	3	1	4

^{a/} Biomass is expressed as milligrammes produced from 100 ml of the medium containing 0.5% (w/v) peptone

Table 3

Biomass production vs. optical density of marine micro-organisms
grown on media prepared from different peptones

Test organisms (marine bacteria)	Peptone A		Peptone B		Peptone C		Difco peptone	
	OD	Biomass ^{a/}	OD	Biomass ^{a/}	OD	Biomass ^{a/}	OD	Biomass ^{a/}
SMB - 11	0.0706	18.4	0.0132	14.4	0.0088	2.8	0.0706	9.2
SMB - 12	0.0550	9.6	0.0605	8.4	0.0245	7.6	0.0862	19.6
SMB - 14	0.3410	52.8	0.2218	36.4	0.5230	78.4	0.2920	21.2
SMB - 17	0.2420	34.4	0.1550	27.6	0.4690	63.6	0.2900	26.0
Average	0.177	—	0.113	—	0.256	—	0.184	—
Media Rank	3		4		1		2	

^{a/} Biomass is expressed as milligrammes produced from 100 ml of the medium containing 0.5% (w/v) peptone

An important question was whether the process of defatting the raw material conferred any added advantage to the overall performance of the peptone. The results definitely suggest this. However, the actual magnitude of the advantage could be assessed only when more varied types of organisms are tested on a number of different microbiological media incorporating the test peptones. Nevertheless, the present data hold promise of a good variety of peptone being derived from threadfin bream.

ACKNOWLEDGEMENTS

The authors are grateful to Mr. G.K. Kuryan, Director, for his keen interest and encouragement. Technical assistance of N.M. Vasu, Thomas J. Mammottil and R. Thankamma is greatly appreciated. The work formed part of all India Co-ordinated Research Project on Transportation of Fresh Fish and Utilization of Trash Fish supported by Indian Council of Agricultural Research, New Delhi.

REFERENCES

- American Public Health Association, Standards methods for the examination of water and waste water.
1971 Washington, D.C., American Public Health Association 13th ed. p. 537
- Association of Official Analytical Chemists, Official Methods of Analysis. Washington, D.C., Association of
1975 Official Analytical Chemists. p. 15, item 2.049; p. 311, item 18.036; p.312, item 18.044
- Beuchat, L.R., Preparation and evaluation of a microbiological growth medium formulated from catfish waste
1974 peptone. *J.Milk Food Technol.*, 32:277-81
- Green, J.H., S.L. Paskell and D. Goldmintz, Fish peptones for microbial media developed from red hake and from
1977 a fishery by-product, 1977. *J.Food Protect.*, 40:181-6
- Green, J.H. *et al.*, Exploration of experimentally produced fish peptone for growth of micro-organisms.
1973 *Dev.Ind.Microbiol.*, 14:310-6
- _____, New methods under investigation for the utilization of fish solubles, a fishery by-product, as a
1973a means of pollution abatement. *In* Food processing waste and management. Proceedings of the
Cornel Agricultural Waste Management Conference, Ithaca, N.Y., Cornell University. pp. 51-68
- Hale, M.B., Making fish protein concentrate by enzymatic hydrolysis. *NOAA Tech.Rep.NMFS (Spec.Sci.*
1972 *Rep.Fish Ser.)*, (657)
- Mackie, I.M., Proteolytic enzymes in recovery of proteins from fish waste. *Process.Biochem.*, 9:12-4
1974
- Malushko, L.V., Cultivation of rodent typhoid bacteria on fish hydrolysates. *Veterinariya, Mosc.*, 42:111-3
1966 (English transl.)
- Meinke, W.W. and K. Mattil, Autolysis as a factor in the production of protein isolates from whole fish. *J.Food*
1973 *Sci.*, 38:864-6
- Snieszko, S.F., F.J. Griffin and S.B. Priddle, A new bacterium (*Hemophilus piscium* n.sp.) from ulcer disease of
1950 trout. *J.Bacteriol.*, 59:699-710

- Spinelli, J., B. Koury and R. Miller Approaches to the utilization of fish for the preparation of protein isolates.
1972 Isolation and properties of myofibrillar and sarcoplasmic fish proteins. *J. Food Sci.*,
37:599-603
- _____, Approaches to the utilization of fish for the preparation of protein isolates. Enzymic modifications
1972a of myofibrillar fish proteins. *J. Food Sci.*, 37:604-8
- Stephens, N.L., Preparation and evaluation of two microbiological media from shrimp heads and hulls.
1976 *Appl. Environ. Microbiol.*, 21:1-6
- Strasding, G.A. and J.M. Melville, Salmon canning waste water as a microbial growth medium. *J. Fish. Res. Board*
1972 *Can.*, 29(6):1769-71
- Tarr, H.L.A. and C.P. Deas, Bacteriological peptones from fish waste. *J. Fish. Res. Board Can.*, 7(9):552-60
1949
- Anon., 'Beef' extract from tuna juices. *Austr. Fish.* 32(12):13
1973

FISH SILAGE TRIALS IN HONG KONG

by

P.J. Gaiger
Agriculture and Fisheries Department
Hong Kong

Abstract

Production of silage for animal feed by acidification of whole fish or offal was investigated as a means of utilizing periodic gluts including small purse-seined fish. Fifty-three samples, each of 4-10 kg, were selected over 14 months and subjected to various degrees of comminution. Samples were hand-mixed in a plastic bucket with quantities of 85 percent formic acid, usually 3.5 percent by weight, and kept indoors in covered buckets at ambient temperatures of 10–30°C. All whole fish liquefied satisfactorily; offal tended to liquefy at a slower rate, have a more pungent odour and appeared to need more than 3.5 percent acid. Comminution was unnecessary for small fish, e.g. anchovies (*Stolephorus* spp.), but filefish (*Monocanthus* spp.) and offal needed mincing. Scads (*Decapterus* and *Trachurus* spp.) and similar fish of 10-15 cm length needed mincing in the winter, but a coarser comminution, or none at all, was adequate in the summer. Stirring facilitated liquefaction, which varied in speed from 12 h to five weeks. Final viscosity varied; scads producing a glutinous product in the winter, anchovies a watery liquid. Whole fish silages maintained a pleasantly malty smell for one to six months. Deterioration involved the formation of a mould (*Aspergillus*) or infestation with a small dipterid fly. Crude protein was assayed at 15.6-17.0 percent and fat at 1.2-7.0 percent for whole fish. A limited trial showed that whole fish silage supported adequate growth in weaner pigs when incorporated in a cereal-based feed. Possible lines of future development including a small-scale plant for mechanized batch production are discussed.

INTRODUCTION

Fish silage, or liquid fish protein as it has been called, has been widely studied in temperate areas (Tatterson and Windsor, 1974) and 25,000 tonnes were produced annually in Denmark by 1972 (Disney, Tatterson and Olley, 1977). Recently the Tropical Products Institute, London, has developed a dried silage product for use in the tropics, utilizing cheap local vegetable products, e.g. cassava, as a source of energy in the preparation of simple animal feed at the village level (Disney, Tatterson and Olley, 1977). Hong Kong has an in-shore purse seine fishery for small pelagic fish and the catch serves a variety of uses, the majority nondomestic and including bait fish, aquaculture and pig feeds. Periodic gluts occur, the surplus goes either to waste or for use as cheap fertilizer. Trials were initiated to determine whether a better return could be achieved by using the fish to produce fish silage. These were subsequently extended to include demersal fish and fish offal.

MATERIALS AND METHODS

Small pelagic fish landed chilled from purse seiners within 12 h or capture were the original target of the trials but other chilled pelagic species from trawlers and offal from demersal and pelagic fish, used in the manufacture of fish balls, were also used, as shown in Table 1.

The offal comprised either heads and guts removed by hand or the skin and frames remaining after treatment in a meat/bone separator. Following U.K. practice (Tatterson and Windsor, 1974), commercial-grade formic acid (85 percent) was used exclusively.

The raw material was mixed with acid in batches of 4-10 kg in 20 1 low-density polythene buckets. Initial comminution, when carried out, was either by chopping with a butcher's knife or by mincing using a domestic hand mincer on a coarse setting. Acid was gradually added to the raw material from a 500 ml measuring cylinder and the mixture was stirred with a wooden paddle for about 5 min or until thorough mixing was considered to have been achieved. Generally, a quantity of acid equivalent to 3.5 percent by weight of the raw material was used to produce a pH of 3.5-3.9 in whole fish silages but other percentages ranging from 2.5-4.5 percent were also tested.

Table 1

Raw material used in silage treatments

Family	Common name	Scientific name	Number of samples	(Treatments)
Clupeidae	Gizzard shad	<i>Clupanodon punctatus</i>	1	(2)
	Sardine	<i>Sardinella jussieu</i>	1	(1)
	Sardine	<i>Sardinella perforata</i>	2	(3)
	Sardine, mixed	<i>S. jussieu/perforata</i>	1	(1)
	Round herring	<i>Dussumieria basseltii</i>	1.5	(3)
Engraulidae	Anchovy	<i>Stolephorus</i> spp.	6	(10)
	Long-jaw anchovy	<i>Thrissa dussumieri</i>	3	(3)
Apogonidae	Cardinal fish	<i>Apogon quadrifasciatus</i>	1	(1)
Carangidae	Scad	<i>Decapterus maruadsi</i>	4.5	(7)
	Scad	<i>Trachurus japonicus</i>	5.5	(8)
	Scads, mixed	<i>Decapterus</i> and <i>Trachurus</i>	2	(3)
	Scads, mixed	<i>D. maruadsi</i> and <i>Caranx kalla</i>	1	(1)
Leiognathidae	Slipmouth	<i>Leiognathus bindus</i>	1	(3)
	Slipmouth	<i>Leiognathus insidiator</i>	4	(5)
Scombridae	Slimy mackerel	<i>Scomber japonicus</i>	1	(2)
Balistidae	Filefish	<i>Monocanthus</i> spp.	2	(5)
Tetraodontidae	Puffer fish	<i>Tetraodon</i> spp.	1	(1)
Fish offal	Mixed fish		2	(2)
	Yellow belly	<i>Nemipterus bathybius</i>	5	(6)
	Croakers	Sciaenidae	1	(2)
	Lizard fish	<i>Saurida</i> spp.	3	(3)
	Crevalle	<i>Caranx equula</i>	1	(2)
	Sea bream	<i>Evynnis cardinalis</i>	1	(2)
	Hairtail	<i>Trichiurus haumela</i>	1	(1)
Total			53	(77)

The mixture was stored in the mixing bucket covered with a loose-fitting lid and allowed to stand in a well-ventilated, non-air-conditioned room. An alternative form of storage, in filled airtight polyethylene containers of 3.5 l total capacity held in an air-conditioned room at 25°C, was investigated halfway through the trial.

Only subjected tests were used to assess the degree of maturity, freshness and palatability of the silage. Table 2 shows the criteria used to determine the four stages of maturity. Freshness was generally tested by smell, a pleasant malty odour being typical of a sterile, palatable product, although offal silage was generally more pungent. Putrefactive odours were seldom detected in isolation from other signs of deterioration, but generally followed the appearance of dipterid maggots or the growth of an *Aspergillus* mould. Quantities of fat in the raw material induced a slightly rancid smell in the silage. Measurements of pH were carried out infrequently, initially by pH paper and later by meter. Proximate analyses were carried out by the Government Laboratory, Hong Kong. Fat content was assayed more extensively by staff and undergraduates of the Chemistry Department, University of Hong Kong. Two methods of fat assay were used. For mature silage, the sample was homogenized in saturated aqueous sodium chloride and petroleum ether, and the fractions were separated physically, the aqueous layer being re-extracted with petroleum ether. The organic extract was dried over anhydrous sodium sulphate, filtered, and the solvent removed under reduced pressure. For raw fish, a sample of minced fish was blended with a 2:1 mixture of methanol and chloroform and the resultant mixture was allowed to equilibrate before being subjected to a similar extraction process. Differences in results from the two methods are attributable to differences in the polarity of the respective solvents used and to the polarity of the lipids thereby extracted.

Table 2

Maturity stages of silage

Stage	Description
1	Most fish bodies without obvious sign of disintegration (applies to whole raw material only)
2	A few fish bodies still basically undigested (applies to whole raw material), or skeletal parts still with some flesh adherent (applies to comminuted raw material)
3	Slurry with most skeletal parts undigested
4	Material homogeneous, when stirred, except for a few eye lenses and other hard parts. Viscosity variable

Air temperature were taken either from the records of the Royal Observatory, Hong Kong, or from a minimum-maximum mercury thermometer installed at the storage site.

RESULTS

Degree and speed of liquefaction

All samples of whole fish liquefied satisfactorily before deterioration occurred, except for samples of filefish (*Monocanthus* spp.) that had been given little or no initial comminution. Salted anchovies (*Stolephorus* spp.) also failed to liquefy but both genera liquefied satisfactorily when treated differently. The viscosity of the prepared silage has not been considered in the arbitrary classification of liquefaction. It ranged, however, from an almost watery consistency when derived from anchovy to that of a heavy, jelly-like slurry when produced from scads (*Decapterus* or *Trachurus* spp.) in the winter. Besides manifesting interspecific variation, viscosity also varied according to season and to the degree of initial comminution, although few objective observations were made. In the early stages, some silage yielded a clear supernatant (up to 10-15 percent of silage volume) above a dense settled mass of semi-digested material; other silages even of the same species were almost homogeneous and showed little sign of separation.

The time taken for each sample to undergo complete liquefaction varied from two to over 90 days, as indicated in Fig. 1. Whole fish treated in winter or spring took longer to liquefy than in summer, e.g., from one to two months in spring but only from one to two weeks in May-July 1977. Chopped or minced fish liquefied slightly faster than whole fish of the same species except in the case of smaller pelagics, such as anchovies or young scad, which did not require comminution. Interspecific differences in the speed of liquefaction may be the result of differences in body size rather than in chemical composition. However, whole fish with tough or scaly exteriors such as filefish took longer to liquefy than other species. Fish offal took longer to liquefy than whole fish; one month was the shortest period. Furthermore, the resultant silages often had a much stronger odour, due in part to the semi-digested gut contents of some of the larger species involved. Several offal silages tended to putrefy before liquefaction was complete, possibly because the volume of acid used (3.5 percent as for whole fish) was insufficient to cope with the large proportion of the raw material that was calcareous, resulting in a pH greater than 4.0.

Storage life

The storage life of silage as measured from the date of its preparation is shown in Fig. 2. The period of freshness or palatability shows seasonal changes similar to that for liquefaction (Fig. 1). Spoilage occurred more rapidly during the warm, humid summer months; in June-July some samples of scad spoiled within two weeks. On the other hand, samples of sardines maintained a good condition for over 12 months, retaining a good odour to the end, apart from a rather greater rancidity than in the initial stages. Anchovy silage was notable in not becoming infested with dipterids. These insect larvae were tolerant of a pH as low as 3.0. Besides dipterid infestation, the most common cause of deterioration of quality was the growth of *Aspergillus* mould, initially on the exposed internal surfaces of the container and in later stages as an encrustation on the silage itself.

Promixate analysis

The results of the proximate analyses conducted on fully liquefied silages are shown in Table 3. As expected, the values were similar to those of raw whole fish or offal.

Crude protein content was remarkably constant at 15.6-17.3 percent; only anchovy at 11.8 percent fell outside this range. Protein percentage for offal silages were close to the bottom of the range for whole fish.

Table 3

Proximate analysis of silage at periods of 21-90 days after preparation^{a/}

Common name	Sample month	Composition in silage by weight (%)				pH	Scientific name
		Crude protein	Fat	Ash	Water		
Sardine	September	15.98	3.83	3.21	74.14	3.91	<i>Sardinella jussieui</i>
Sardine	October	15.81	1.23	3.66	77.01	3.91	<i>Sardinella jussieui</i>
Long-jaw anchovy	November	15.99	10.39	8.76	67.89	3.96	<i>Thrissa dussumieri</i>
Anchovies	June	11.76	1.45	2.95	81.25	3.80	<i>Stolephorus</i> spp.
Scads	July	15.59	3.39	3.43	75.74	3.76	<i>Trachurus japonicus</i>
Scads	August	16.64	5.65	3.41	74.09	5.75 ^{b/}	<i>Trachurus japonicus</i>
Scads	August	17.28	2.59	3.59	73.76	4.05	<i>Decapterus maruadsi</i>
Slipmouth	October	16.64	2.87	3.34	83.38	3.93	<i>Leiognathus insidiator</i>
Slipmouth	November	16.69	1.61	3.95	78.00	3.93	<i>Leiognathus insidiator</i>
Slimy mackerel	April	16.60	2.25	2.80	76.80	3.90	<i>Scomber japonicus</i>
Offal from lizard fish	May	15.10	3.49	5.40	72.70	4.20	<i>Saurida</i> spp.
Offal from yellow belly	June	15.70	4.41	8.20	69.50	4.40	<i>Nemipterus bathybius</i>

^{a/} Analysis carried out by the Government Chemist, Hong Kong^{b/} 2.5 percent acid in original mixture

Fat content was more variable than protein content, ranging from 1.2-5.7 percent in nine of the ten samples of whole fish and in the upper half of this range for offal. A sample of long-jaw anchovy (*Thrissa dussumieri*) had a fat content double that of the next highest value. A more intensive screening of 48 samples for fat content was carried out, the results of which are shown in Table 4. The highest fat contents recorded for fish offal were 6.9 and 8.1 percent respectively, although for raw fish one sample (of scad) was assayed at 9.3 percent. In general the highest fat values occurred between July and September, and the lowest between April and June.

Temperature

Hong Kong undergoes marked seasonal changes in temperature despite its maritime location. Five-day minima, maxima and means of air temperature at two locations are shown in Fig. 3. The longest series of data available is that from the Royal Observatory in the centre of the urban area. Records are also available for part of the duration of the trials from the experimental site at the Aberdeen Fisheries Office; this site has less extreme values with a maximum of 31.5°C in June and July but values are not available for the coldest period, which the Royal Observatory records demonstrate was January and February, with minima of between 5.5 and 7.0°C. Five-day mean values correspond closely for the two sites and range from 9.5°C in February to 30.5°C in August.

DISCUSSION

Only with offal was there any difficulty in achieving liquefaction and preservation using 3.5 percent of 85 percent formic acid. This probably resulted from the substantial proportion of calcareous matter contained in the offal and was improved considerably by mincing. James, Iyer and Nair (1977) found that 5 percent of 98 percent formic acid was required to maintain a pH of no greater than 4.0 in silage produced from *Leiognathus* sp. Present trials, however, including those on the same genus, suggest that even 3.5 percent of 85 percent formic acid is excessive for whole fish and that a concentration of 2.5-3.0 percent may be adequate. On the other hand, for some offal a concentration of up to 4 percent or greater may be necessary.

It must be presumed that the marked seasonal changes in temperature shown in Fig. 3 are responsible for the seasonal differences in the rate of liquefaction (Fig. 1), final viscosity and tendency to spoil (Fig. 2). Rigorous comparison of changes in such parameters with temperature is made difficult by variation in the raw material and degree of comminution; Table 5 summarizes the speed of liquefaction and deterioration of two important groups of raw material at different times of the year and temperatures. It would appear that the critical temperature for liquefaction is about 25°C; below this point it takes several weeks, above it only a few days.

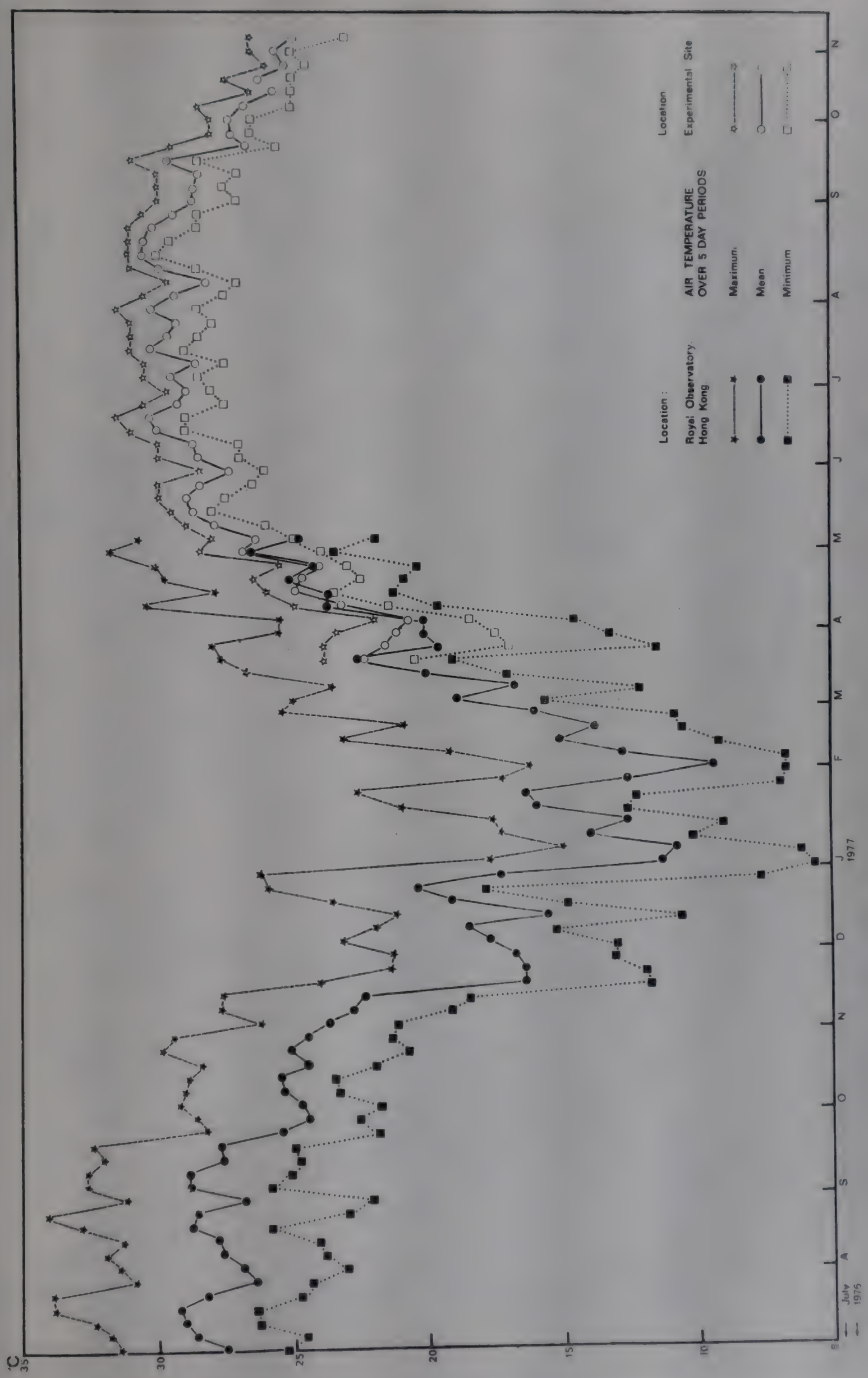
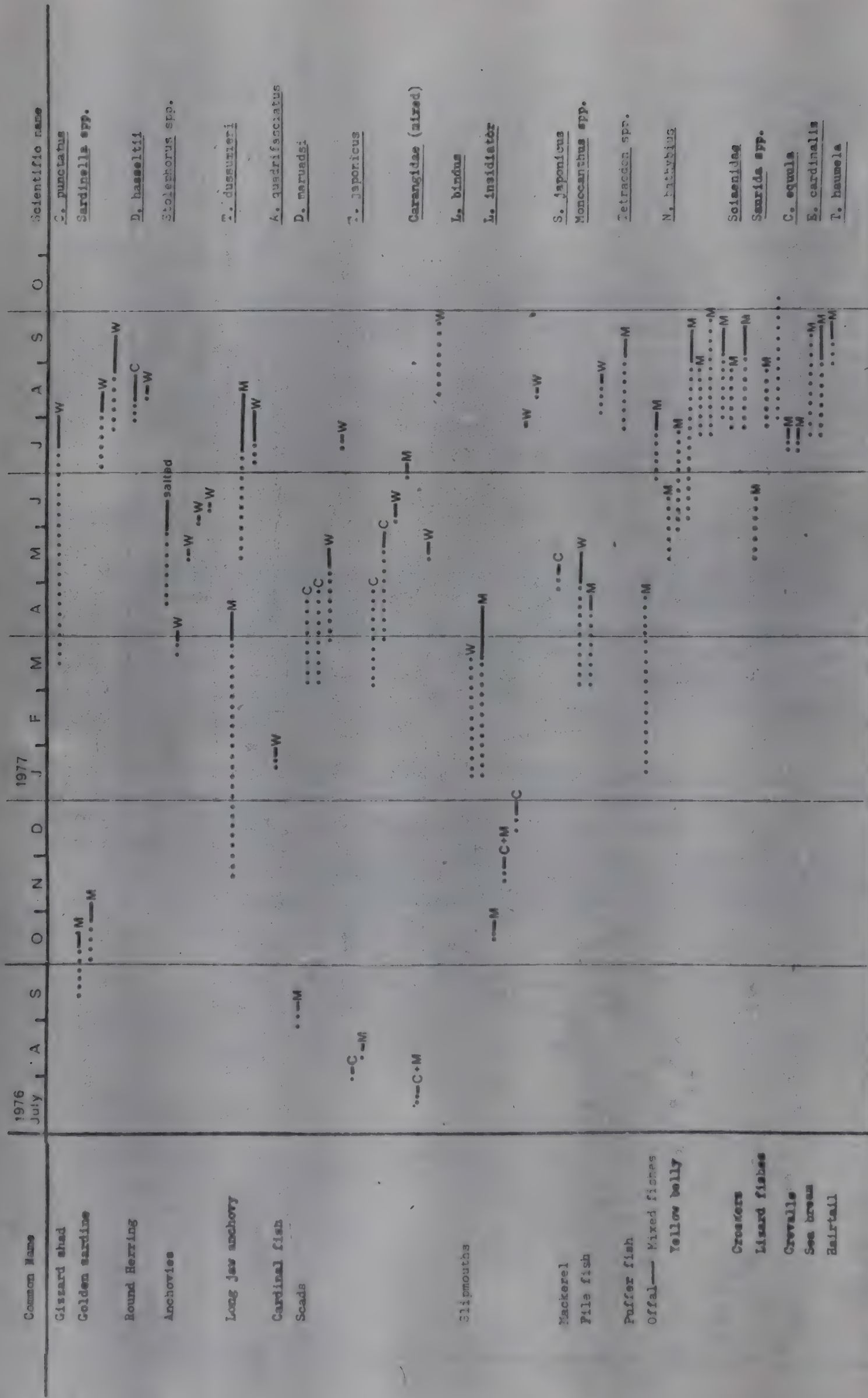
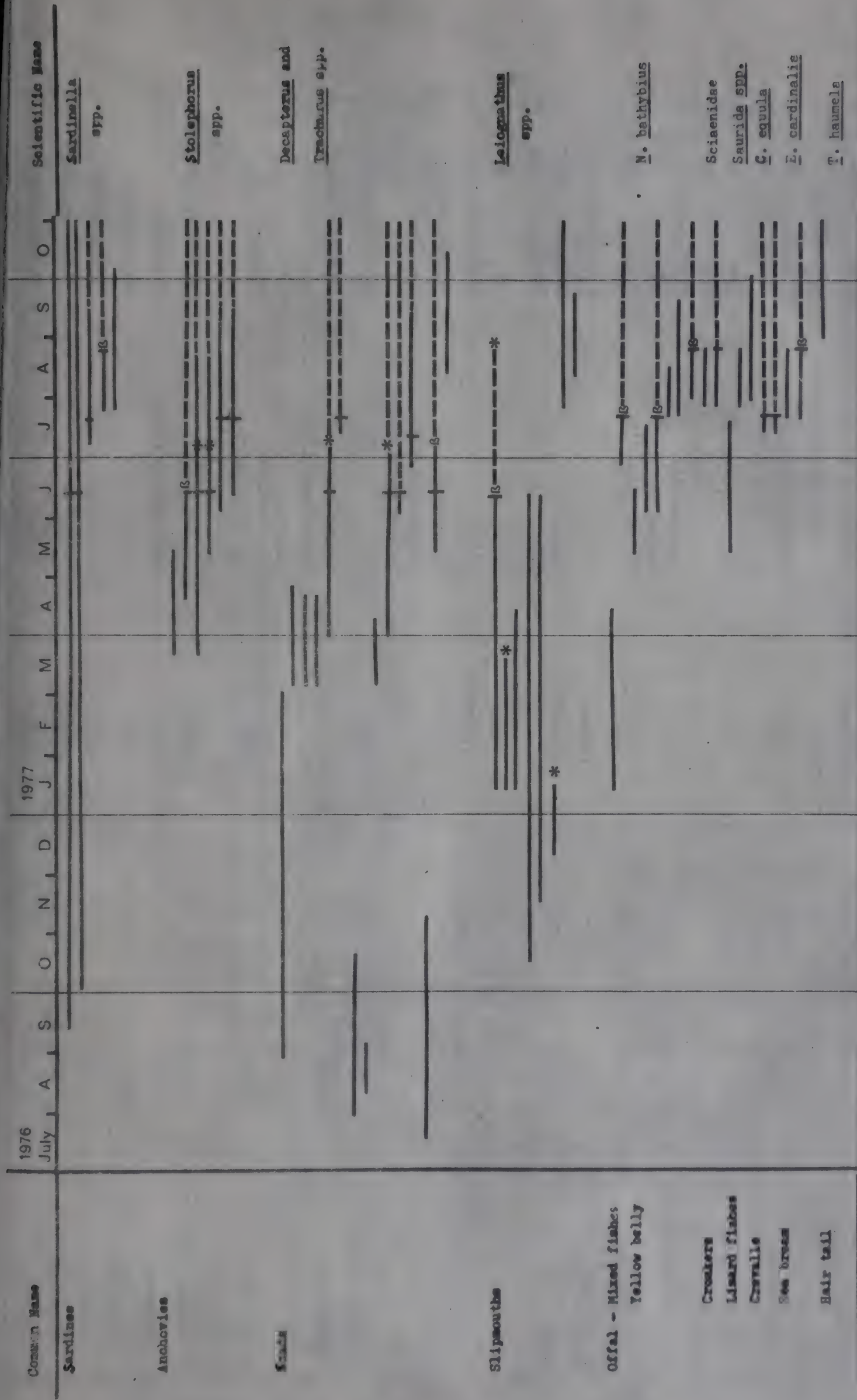


Figure 3 — Five-day means, minima and maxima of air temperature at two locations in Hong Kong



W, C, or M after each record denote that treatments were on Whole(not comminuted), Chopped or Minced material respectively

Figure 1: The time taken for material to reach partial (Stage 1-3: dotted line) and full (Stage 4: solid line) initial assimilation



Vertical line indicates that a sub-sample was transferred to an air tight container,

β that deterioration had begun at the time of transfer,

* that the sample was withdrawn for use before deterioration had begun.

Figure 2 - The duration of storage of fish silage in good condition in loosely covered (solid line) or air tight (dashed line) polyethylene containers

Table 4

Fat content of silage by species^{a/}

Common name	Range of fat content	Number of samples assayed	Month of highest fat content	Remarks	Scientific name
Gizzard shad	3.0-4.9	2	September		<i>C. punctatus</i>
Sardines	1.2-4.5	5	July	2 samples also assayed raw	<i>Sardinella</i> spp.
Round herring	1.9-2.6	2	August	Samples also assayed raw: one at 5.4% (July)	<i>D. hasseltii</i>
Anchovy	1.2-3.1	5	March	—	<i>Stolephorus</i> spp.
Long-jaw anchovy	0.77-4.6	2	July	3 samples also assayed raw: one at 6.6% (July)	<i>T. dussumieri</i>
Cardinal fish	4.6	1	January	—	<i>A. quadrifasciatus</i>
Scads	0.9-6.9	13	March	1 sample also assayed raw: 9.3% (July)	<i>Decapterus</i> spp./ <i>Trachurus/C. kalla</i>
Talang	5.1	1	September	—	<i>Chorinemus lysan</i>
Slipmouth	1.3-3.8	6	September	1 sample also assayed raw: 4.2% (September)	<i>Leiognathus</i> spp.
Slimy mackerel	2.1	1	April	—	<i>Scomber japonicus</i>
Filefish	1.2	2	—	1 sample also assayed raw: 1.9% (August)	<i>Monocanthus</i> spp.
Puffer fish	1.8	1	July	—	<i>Tetraodon</i> spp.
Offal from:					
Yellow belly	3.3-5.9	5	May	—	<i>Nemipterus bathybius</i>
Croakers	2.6	1	July	Heads and guts only	<i>Sciaenidae</i>
Lizard fish	0.6-3.8	2	May	—	<i>Saurida</i> spp.
Crevalle	6.3	1	July	—	<i>Caranx equula</i>
Sea bream	2.4	1	July	—	<i>Evynnis cardinalis</i>
Hairtail	6.5-8.1	2	August	—	<i>Trichiurus haumela</i>

Table 5

The time taken for fish samples to liquefy and the storage life of the resultant silage as related to the date of preparation and ambient temperature

Fish material	Modal length (cm)	Date of preparation (1977)	Number of days to reach			Mean ambient temperature		
			stage 3	liquefaction stage 4	onset of deterioration a/	at date of preparation	after 1 week	after 1 month
Anchovy (<i>Stolephorus</i> spp.) whole	9	21/03	7	12	84+	22	22	24
	4	13/05	3	6	32+	29	29	30
	4.5	3/06	1	3	36-47	28	31	29
	5	11/06	2	4	9+	31	30	30
Scad (<i>D. maruadsi</i>)	17	30/03	21	47-70	16	20	24	26
	15.5	13/07	2	7	7+	30	29	31
Scad (<i>T. japonicus</i>)	19	30/03	21	47-70	21-26	20	24	26
	8	2/06	3	12	12+	28	30	29
	8	2/06	1.5	4	12+	28	30	29

a/ A number followed by + indicates that after that number of days the silage had not begun to deteriorate but was thereafter withdrawn for use

As regards spoilage, it should be noted that the summer months are also marked by a much higher humidity and this encourages spoilage. Fig. 2 indicates a marked difference in perishability between silage stored in loosely-covered and airtight containers, due perhaps, in part, to differences in ambient temperatures at the respective storage sites. However, it is more likely that the longer storage life in the airtight containers is attributable to the lessened opportunity for contamination by mould spores and dipterid adults and the prevention of water vapour and acid exchange with the atmosphere, which would lead to an increase in pH on the unsubmerged inner surfaces of the container. Such surface was more limited in area in the (smaller) airtight containers which were invariably filled to the top.

Utilization of fish silage

Table 3, which shows the proximate analysis of several silages, indicates the value of silage as a high animal-protein feed supplement. Apart from the anomalous sample of anchovy, for which there is no ready explanation as yet, protein values are constant at about 16 percent of wet weight or 60 percent of dry matter. Fat content at 1.3-6.9 percent (4.25 percent of dry matter) is probably not high enough to cause a serious taint problem except at the higher level but may be sufficient to provide a good source of energy in a feed. Bacteriological tests did not indicate the presence of any important pathogens in silage of pH 4.0 or less. *Aspergillus*, however, is apparently tolerant of a fairly low pH and could prove a nuisance in an animal feed. The inhibition of its development in airtight containers indicates that, with careful storage, the problem can be minimized.

A limited palatability and growth trial was carried out over 137 days at Ta Kwu Ling Pig Breeding Centre, New Territories, Hong Kong. Four local-breed weaner pigs with an initial weight of about 8 kg were reared through to about 20 kg; two were on a control diet based on maize with a soybean and meat/bone-meal high protein supplement, and two on a similar diet with silage completely replacing the high protein supplement. Despite not being neutralized, the silage feed was acceptable but growth rate was less than with the control diet. More rigorous trials are planned. Intensive local pig farming yields about 15 percent of Hong Kong's demand for fresh pork and a significant proportion of the industry uses restaurant waste in wet feed systems that could easily be adapted to use wet silage. The major problems facing the ready use of silage in the pig industry are its cost to the farmer, both absolute and relative to protein and energy content, and the possibility of fishy taint in the meat produced. Conflicting evidence arose from overseas trials to assess the occurrence of tainting, though a level of less than 5 percent of fish oil in the animal feed dry matter has been deemed acceptable in the U.K. (Disney, Tatterson and Olley, 1977). To achieve a constant known fat level, the variability of fat content in the raw material indicates it will be necessary to blend silages from different sources. Despite the extra storage space and handling required for blending, it should permit the solution of two further utilization problems.

First, silages occasionally contain hard bones too coarse for the alimentary tract of a feeding animal, e.g., the strong dorsal spines (triggers) of filefish. These disintegrate in time but well after full liquefaction of the remainder; the silage could therefore be used much earlier if the bone was allowed to settle out and the liquid was decanted off. Second, silages of low viscosity, i.e., particularly those prepared from very small fish in the summer, present several problems in use, settle readily into components of different composition and require careful transport to prevent spillage. Blending these with more viscous silages could ameliorate the situation provided that the resulting protein and fat content were suitable. Disney (personal communication) asserts that pigs are quite capable of assimilating silages, particularly those of small soft-bodied fish, well before their full liquefaction. Coarser material, e.g., offal and filefish, would have to be well comminuted; a practice notwithstanding this, essential for thorough acidification.

In the poultry industry most chicken farmers use a dried feed base but duck farming is carried out with a wet feed generally incorporating trash fish. The latter therefore would appear to offer potential for the use of the liquid fish silage. No trials have as yet been conducted.

Commercial production

It has been shown that for all small species, e.g., anchovies, slipmouths, whole fish may be readily hand mixed in small batches to undergo rapid liquefaction, yielding a product with a long storage life. A simple scaling-up of this nonmechanized process, using mixing containers of up to 100 l or more, is possible. Such species constitute only a small proportion of the potential silage material and alone would be insufficient to support a significant year-round demand for feedstuff. The remaining species tested, particularly fish offal, need at least some degree of comminution before acidification and therefore mechanized mixing for quantities greater than 20 kg.

In association with plans to conduct more extensive feeding trials, a pilot-scale plant has been proposed and is illustrated diagrammatically in Fig. 4. Precise control of the proportion of acid to fish material would be difficult in a continuous production plant, hence the proposal involves batch production of 300 kg of raw material per hour; i.e., the methods reported here are scaled up by a factor of 10. A variety of comminuting and or mixing machinery was considered; for large-scale production a type of hasher might serve both comminuting and mixing functions but, for the present, they are achieved by different components. Comminuting is by an electric-powered meat mincer. Mixing will be carried out in a mixer designed for blending meat products, with a mixing bowl of 50 kg capacity that can be tilted to discharge the mixture and mixing achieved by inclined crust of raw material to rise up the container. Supplementary stirring in the maturing containers is, therefore, desirable after initial mixing to ensure the thorough acidification of the raw material. Manual stirring or a simple mechanical stirrer would suffice.

The compact plant, estimated to cost HK.\$ 16,000¹, could be installed at an urban wholesale fish market and derive its raw material from processing offal as well as small pelagic and demersal fish landed in excess of normal requirements. Storage and transport will be in 100-l heavy-duty plastic drums which will allow both versatility in mode of transport without expensive handling systems and the ability to separate and, subsequently, blend silages from different material. For blending, a concrete tank of several tonne capacity will also be required.

Economics of production

In Hong Kong there are no fishmeal reduction plants so that the alternative of transporting raw material to such a plant does not exist and the economic viability of silage production may be broadly assessed against the imported cost of fishmeal

Weekly operating costs for the proposed plant illustrated in Fig. 4 have been calculated assuming three hours operation for three days per week at full capacity. Costs are included for the basic alternative raw materials, whole fish and fish offal, and a blend of the two, and it is assumed that these materials may be treated with slightly less acid than during the present trials. Fixed weekly costs including power, labour and delivery of product but excluding capital servicing costs and rental of space, total of HK.\$ 315; this ranges from 16-37 percent of delivered cost.

1/ HK. \$1 = U.S. \$ 0.28 (April, 1978)

Table 6 shows the estimated cost of raw materials for one week's production (2.7 tonnes) and the delivered cost of silage prepared from various raw materials at three possible price levels. The delivered costs may be compared to that of fishmeal of HK.\$ 2,280 per tonne. Assuming the fishmeal to have a protein content four times that of silage, its price per unit weight of protein would reduce to HK.\$ 570. On this basis, 100 percent offal silages are substantially cheaper than fishmeal; the 1:1 blend of whole fish and offal would also be cheaper. However, only at the lowest raw material price would a 100 percent whole fish silage be cheaper than fishmeal. Such valuations, however, ignore the high-energy value of the fat contained in the silage which would be greater than in the meal.

No statistics are available on the current availability of suitable whole fish at the tabulated prices, although most of the samples reported here were obtained at a higher price than in Table 5. On the other hand, five tonnes of offal are available every day at two urban markets at a price toward the low end of the tabulated range. The fat content of most of the raw material sampled is too low to justify its separation economically, though with some offal reduction of fat content may be desirable from the animal feed view point.

The value of silage production as a method of utilizing fish and their wastes in Hong Kong is seen as the low capital cost of the plant and simplicity of its operation enabling plant to be brought into use easily when the fish supply allows. Should offal prove to yield an attractive animal feed in silage form, then the method would be commercially viable on a regular basis at daily throughputs well below those necessary for a fishmeal plant.

ACKNOWLEDGEMENTS

Particular thanks are due to Mr. Lai Siu-chung of Fisheries Development Division for assistance in silage production. Thanks are also due to staff of the Government Laboratory, Hong Kong, for proximate analyses, and staff and undergraduates of the University of Hong Kong, Chemistry Department, for fat assays; the Tropical Products Institute, London, who gave encouragement and advice throughout the trials: The Director of Agriculture and Fisheries for permission to carry out this work, and colleagues in the Agriculture and Fisheries Department who gave valued assistance.

REFERENCES

- Disney, J.G., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In Proceedings of the Conference on 1977 the handling, processing and marketing of tropical fish*, London, 1976. London, Tropical Products Institute, pp. 231-40
- James, M.A., K.M. Iyer and R.M. Nair, Comparative study of fish ensilage prepared by microbial fermentation 1977 and formic acid silage. *In proceedings and marketing of tropical fish*, London, 1976. London, Tropical Products Institute, pp. 273-5
- Tatterson, I.N. and M.L. Windsor, Fish silage *J.Sci.Food Agric.*, 25:369-79
1974

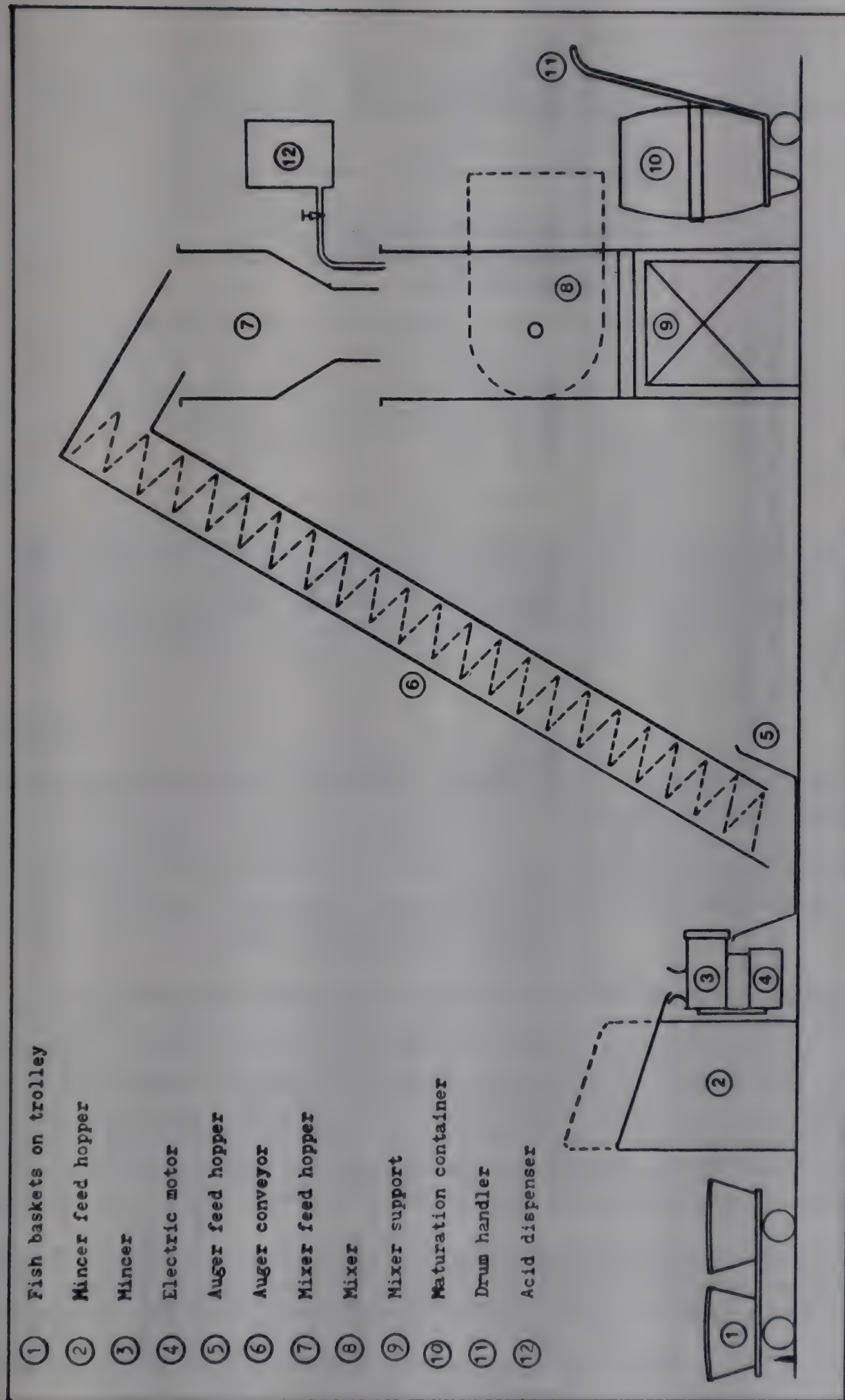


Figure 4 — Diagram of proposed batch-feed pilot scale silage plant of 300 kg/h theoretical capacity

Table 6
Estimated weekly costs of raw materials and delivered products cost in the
production of 2.7 tonnes of silage by the proposed silage plant^{a/}

Price of raw material (H.K. d/kg)	Whole fish	Offal	Whole fish (100%)		Whole fish: offal (1:1)		Offal (100%)	
			Materials cost for one week (HK.\$)	Delivered product cost ^{b/} (HK.\$/tonne)	Materials cost for one week (HK.\$)	Delivered product cost ^{b/} (HK.\$/tonne)	Materials cost for one week (HK.\$)	Delivered product cost ^{b/} (HK.\$/tonne)
Low-price	33	8.3	891	531	558	421	224	311
Medium-price	41	12.4	1 107	611	721	482	335	353
High-price	50	16.5	1 350	700	898	547	445	393
Acid		280	227		265		302	
Quantity of acid used as percentage by weight of raw material			3		3.5		4	

a/ Operating nine hours per week

b/ Inclusive of estimated weekly cost of HK.\$ 315 for power, labour and transport

FISH SILAGE: PREPARATION, UTILIZATION AND PROSPECTS FOR DEVELOPMENT

by

J.G. Disney, W.H. Parr and D.J. Morgan¹
Tropical Products Institute
London, U.K.

Abstract

Fish wastage is a major problem in the IPFC region and conversion to animal feed by acid ensilage represents one means of utilization. The paper outlines methods of preparation of liquid and dried products using low cost/low technology methods and reports on methods of feeding the product to pigs and poultry. The prospects for fish silage and its use for pig, poultry and fish feed are reviewed.

INTRODUCTION

The acid ensilage of fish is not a new process. The basic methodology was developed more than 50 years ago and substantial quantities are produced in countries such as Denmark and Poland. In recent years, however, there has been renewed interest in fish silage as it represents a means of utilizing waste fish and fish offal where conventional fishmeal production is inappropriate. In the United Kingdom, for example, the reduced number of fishmeal plants, combined with high transport costs, has led to research and development work on fish silage and two commercial units are currently under construction.

In the tropics, every effort must be made to preserve fish for human food but there are many situations where this is impossible. Daily and/or seasonal variations in catch, transport difficulties, inadequate processing facilities, etc., occur frequently in tropical fisheries and considerable quantities of fish are wasted. A number of national as well as international groups are investigating conventional and novel means of reducing this wastage; silage production is one of several processes under investigation in a number of countries. Recent developments in fish silage and the prospects for production in the tropics have been reviewed by Disney *et al.* (1977). Summer (1976) has also carried out a feasibility study on fish silage production in the IPFC region. The growing demand for animal feed in many tropical countries is a further reason for utilizing waste whenever possible.

The present paper outlines the methods for preparing and utilizing fish silage in the tropics and reviews the prospects for commercial production in the IPFC region. The paper deals with acid silage only and does not consider microbiological fermentation although the latter could also have considerable potential in Southeast Asia.

1/ Present address: B.P. Nutrition (Ireland) Ltd., Tallaght, Co., Dublin, Ireland.

RAW MATERIAL FOR SILAGE PRODUCTION

Fish wastage can arise from a number of causes:

- (a) By catch from shrimp fish which is discarded at sea;
- (b) By-catch which is brought ashore but is poorly utilized;
- (c) Daily or seasonal gluts of fish;
- (d) Offal from fish processing plants.

On a world-wide basis losses from such sources are estimated by FAO to amount to four to five million tonnes per annum (James and Krone, 1977). In the IPFC region the causes of wastage listed above are commonplace although the extent of the waste varies from country to country. Sumner (1976) carried out a detailed review of wastage in several countries in the region and concluded that several hundred thousand tonnes of raw material per annum could, theoretically, be available for conversion into fish silage. The main source of this raw material would be:

- (a) Trash fish landed in Thailand and Malaysia, some of which is currently converted into low-quality fishmeal;
- (b) Shrimp by-catch discarded at sea, the quantities involved being far in excess of those actually landed;
- (c) Seasonal gluts of fish such as the sardine fishery of the Bali Straits.

The availability of waste fish suitable for silage production will vary from country to country and from location to location. The greatest potential is for silage produced at sea on board shrimping vessels but land-based opportunities are also considerable.

Where investment capital is available and the wastage occurs at a central point, the preferred solution may be its reduction to fishmeal. In many isolated areas, however, where the quantities available are smaller and variable, production of fish silage could provide a means of utilizing waste fish as animal feed.

METHODS OF PREPARATION

Fish silage is a liquid product, made from minced fish or fish offal, which is preserved with acid to prevent bacterial spoilage. Liquefaction is brought about by the proteolytic enzymes present largely in the gut and skin of the fish. Compared with fishmeal production, fish silage requires little capital investment, involves little technology and is comparatively cheap to produce. The process is also suitable for application at both cottage and industrial levels. The steps involved in the preparation of fish silage are the same regardless of the scale:

1. The fish or fish offal should be minced or comminuted. The particle size required varies with different species, small fish such as sardines or shrimp by-catch may require little comminution but species with tough skins such as shark or trigger fish (*Balistes* spp.) will require mincing.
2. The minced (or comminuted) fish should be acidified to prevent putrefaction. Thorough mixing is necessary to avoid pockets of untreated fish. Mineral acids, organic acids or mixtures of the two can

be used. The choice will depend upon the cost and availability of the acid and the conditions under which the product is prepared. In most cases three percent by weight of formic acid is suitable and commercial grade such as "Bioaid", produced by British Petroleum, is suitable. The different acid mixtures which have been used are considered by Atkinson (1974), Disney *et al.* (1977), Petersen (1953) and Lovern (1965).

3. The fish/acid mixture should be stored to permit liquefaction. Regular stirring is necessary. The process is temperature-dependent and liquefaction is fairly rapid at tropical temperatures; for most species four or five days are sufficient.
4. The liquid product can be fed directly to pigs but a further step is needed to produce poultry feed (see later). A suitable dry material such as cassava flour, rice bran, maize meal, etc., is mixed with the liquid silage and the resulting mix can be sun-dried. The ratio of silage to filler material will depend upon the feeding regime being used.

The equipment used for silage production is largely dependent on the scale of the operation. At the simplest level, plastic containers and mixing by hand have been successfully tested by the Tropical Products Institute in Malawi, Bahrain, Ghana, Solomon Islands and Brunei. Other workers in Indonesia, New Zealand, Australia and Hong Kong have similarly made fish silage and recent work in these countries will be reported at this meeting. The scale of production at the village level is limited by the difficulties of mixing; batches in excess of 20 kg are difficult to mix by hand. For larger scale production, a mechanical mincer/grinder is necessary together with suitable heavy-duty mixing equipment. A pump or measuring device for handling the acid is also advisable together with suitable tanks for liquefaction and storage. A commercial package capable of producing from 300 to 1,000 tonnes of silage per annum can now be purchased in the United Kingdom from British Petroleum (Nutrition) Ltd.

UTILIZATION

As indicated earlier, the silage product may be in a liquid or dried form. Using conventional feeds, liquid feeding systems can have certain advantages over dry feeding methods including reduced labour costs and improved performance (Bosticco *et al.*, 1976). It is logical therefore to consider the use of wet silage in liquid feeding systems for pigs and, in fact, most tests on its use have been carried out in this way. The method of application would depend upon the scale of the operation. The pig producer could mix liquid silage with a balancer meal (containing supplementary minerals and vitamins) purchased from a feed compounder or, alternatively, he could mix the balancer meal himself. On a large scale, the mix could be pumped into feeding troughs but, on a smaller scale, the mixing would be carried out manually in the feeding troughs or immediately before feeding. Feeding trials in the United Kingdom using non-oily and oily fish have resulted in satisfactory growth but problem of taint have occurred with oily fish at higher levels (Smith and Adamson, 1976). No vitamin E supplementation was given in these trials and further work is required to ascertain whether this would have a beneficial effect. The Tropical Products Institute has carried out feeding trials in the Solomon Islands in collaboration with the Fisheries Department using waste from a tuna cannery. The product is made from cooked flesh and offal and is therefore not strictly fish silage as little or no enzymic breakdown occurs. The product is rather preserved by formic acid. Some five tonnes of product are prepared per month on a cottage industry basis and demand from the pig producers is increasingly rapidly.

PIG FEEDING TRIALS

Two trials (the first being a small preliminary study) were carried out to compare fish silage, fishmeal and a commercial protein concentrate as sources of protein for growing pigs in diets based upon rice milling by-products. Large White X Landrace pigs were selected according to weight, sex and thriftiness. All pigs in the second trial were dosed with a vermifuge (Nilverm, ICI) prior to the start of the feeding period and again after a three-week interval. The animals were fed twice daily, at 10.00 and 16.00 hours. The diets were fed wet, about twice the volume of water being added to the meal, or mixture of meal and fish silage, in the trough.

In Trial 1, two groups of six pigs weighing about 43 kg were selected and equalized on the basis of weight and sex. Group 1 was fed a diet containing an imported proprietary protein concentrate as the major protein source; group 2 was fed a diet including fish offal (Table 1). The control diet and basal mix for the silage diet were mixed in 100 kg batches. The required proportions of basal mix and fish silage were weighed out and roughly mixed immediately before each feed. The pigs were weighed every two weeks and slaughtered when they reached about 70 kg liveweight. Feed intake and liveweight again were recorded.

Table 1

Composition of diets, Trial 1
Formulation of meal mixes

Ingredient	Fish silage basal mix ^{a/} (kg)	Control mix (kg)
Broken rice	886.25	705.9
Rice bran	75.8	146.4
Pig concentrate (50% protein)	33.0	147.7
Mineral vitamin supplement	2.2	+
Sodium chloride	2.75	+
	1 000.00	1 000.00
Added to each tonne:		
Vitamin E supplement (25%)	70.0 g	—
Thiamin	4.5g	—

a/ Fed with fish silage in the ratio 1 part fish silage to 2.39 parts meal

+ These ingredients were present in the pig concentrate

In Trial 2 a total of 40 pigs was used, ten per dietary treatment. Each diet (Table 2) was fed to two groups of five pigs with initial average liveweights of 32 and 34 kg respectively. Each group comprised three gilts and two hogs. Pigs were weighed weekly and slaughtered when they reached 65 kg liveweight. Parameters recorded included feed intake, liveweight gain, killing-out percentage and measures of carcass fatness. The carcasses were assessed visually for fat colour and consistency, and a taste panel study was conducted to determine whether any

Table 2

Composition of diets, Trial 2
Formulation of meal mixes

Ingredient	Fish silage basal mix A ^{a/} (kg)	Fish silage basal mix B ^{b/} (kg)	Fish meal diet (kg)	Control diet (kg)
Broken rice	431.1	714.3	643.0	608.0
Rice bran	542.0	258.2	244.0	247.0
Fishmeal	—	—	100.0	—
Pig concentrate (45% protein)	—	—	—	140.0
Limestone	21.5	22.0	9.0	5.0
Salt	2.7	2.75	1.5	—
Mineral vitamin supplement	2.7	2.75	2.5	—
	1 000.0	1 000.0	1 000.0	1 000.0
Added to each tonne:				
Vitamin E supplement (25%)	69.0 g	70.0 g	64 g	—
Thiamin	4.3 g	4.4 g	4 g	—

a/ Fed with fish silage in the ratio 1 part fish silage to 3.7 parts meal

b/ Fed with fish silage in the ratio 1 part fish silage to 2.8 parts meal

Table 3

Analysis of raw materials (%)

	Fish silage	Rice bran	Rice chips	Concentrate
Dry matter	28.6	88.1	86.0	92.8
Crude fat	3.5	10.8	5.4	8.9
Crude protein	20.0	11.7	12.8	43.7
Crude fibre	—	4.1	0.8	7.7
Ash	3.0	7.4	3.3	20.9
Calcium	0.66	0.06	0.04	5.55
Phosphorus	0.55	2.27	0.54	3.74

Table 4

Calculated analysis of total diets fed (corrected to 87% DM), Trial 2
(%)

	Protein concentrate diet	Fish silage diet (low)	Fish silage diet (high)	Fish meal diet ^{a/}
Crude protein	16.7	15.8	17.4	17.2
Crude fat	7.2	8.4	7.1	7.0
Crude fibre	2.6	2.4	1.5	1.5
Calcium	1.00	0.95	1.00	0.89
Phosphorus	1.41	1.47	1.04	1.19

a/ Assuming fishmeal to have the following composition:

DM	92.0 %
Crude protein	61.0%
Fat	9.4%
Calcium	5.2%
Phosphorus	2.9%

'off flavours' were present in the cooked meat. The composition of dietary ingredients is given in Table 3; the analyses of the diets as calculated from these values are given in Table 4. In error, a sample of fishmeal was not retained for analysis, thus arbitrary values were taken for this material.

The results are presented in Tables 5 and 6. Only the overall treatment means are given for Trial 2 since both the heavy and light pigs responded similarly to the treatments. In Trial 1 the pigs on the diet including fish silage performed as well as those on the diet based on the concentrate (Table 5), growth and food conversion efficiency of both groups being satisfactory. No palatability problems were encountered on the fish silage diet.

The mean growth rate of pigs in Trial 2 were lower than those observed in Trial 1, due to the lighter starting weights of the pigs. The better feed conversion efficiencies observed in Trial 2 are also largely attributable to the lighter starting weights, although worm burdens may have been reduced in these animals. All pigs in Trial 2 gave very good performances. Highest weight gains were achieved by those animals on the fish silage (high level) diet, while there was little difference between gains on the fish silage (low level) and fishmeal-based diets. All fish-based diets gave significantly higher rates of gain than the diet based on the proprietary concentrate ($p < 0.05$). Feed conversion efficiency (FCE) figures reflected these results; the fish silage (high level) diet gave the best FCE and the concentrate diet gave the worst. Differences were not significant for this parameter.

Table 5

Growth and feed conversion efficiency (FCE) of pigs fed diets containing fish silage, fishmeal or a proprietary protein concentrate

Trial 1		Source of supplementary protein			
Parameter	Protein concentrate	Fish offal	S E of treatment mean		
Initial weight (kg)	42.6	42.9			
Final weight (kg)	71.9	70.4			
Daily liveweight gain (g)	749.00(a)	756.00(a)	47.1		
FCE (kg feed/kg liveweight gain)	3.03(a)	2.98(a)			
Trial 2		Source of supplementary protein			
Parameter	Protein concentrate	Fish offal (low)	Fish offal (high)	Fish meal	S E of treatment mean
Initial weight (kg)	29.2	29.9	29.5	31.2	
Final weight (kg)	66.4	66.6	66.7	66.5	
Daily liveweight gain (g)	636.00(a)	706.00(b)	718.00(b)	702.00(b)	19.1
FCE (kg feed/kg liveweight gain)	2.83(a)	2.65(a)	2.61(a)	2.64(a)	0.095

Values in each parameter bearing the same letter are not significantly different

Table 6

Carcass characteristics of pigs fed diets containing fish silage, fishmeal or a proprietary protein concentrate (Trial 2)

	Source of supplementary protein				
	Protein concentrate	Fish offal (low)	Fish offal (high)	Fish meal	S E of treatment mean
Killing out %	73.3	74.3	74.6	75.3	0.56
Cold carcass weight (kg)	48.7	49.5	49.7	50.1	
Measure of backfat thickness					
Mean P1 + P3 (mm)	19.85	18.85	20.45	20.8	1.1

Mean killing out percentage for all treatments was 74.4 with no significant differences between treatments, though there was a trend for higher killing out percentage on the fish based diets. Carcass fatness, as indicated by P1 + P3 measurements, did not vary between treatments while visual appraisal of fat colour and texture did not indicate any variations.

The results indicate that formic acid preserved tuna offal is an excellent source of protein for growing pigs, giving very good feeding results while having no adverse effect upon carcass quality at the levels used. Other recent work (Smith, 1976) has indicated that poor meat quality (odour and unpalatability) results when oily fish such as herring is used as the raw material but not when white fish offal is used. In the present work, care was taken to ensure that the level of fish oil in the total ration did not exceed one percent of the dry matter. Supplementary vitamin E was added to the diets in the current work and there is some evidence that this may be beneficial in reducing taint from fish oil. Taste panel studies indicated that there was no discernible taint in pork from the fish silage fed to pigs as compared to the control. Taint problems might be encountered if tuna offal were fed at higher levels; the need for higher levels of fish offal in a practical situation could arise if diets were based on cassava rather than rice and its by-products.

POULTRY FEEDING TRIALS

The preparation of dried fish silage products has been reported by Disney and Hoffman (1976). The principal application of such products is likely to be in poultry feeds although an investigation of the use of silage in wet mash feeding systems for poultry is required especially in smaller manually fed units. The physical nature

of the dried product would enable it to be incorporated directly into a compounded complete feed although batch-to-batch variation would undoubtedly be a problem especially in maintaining reasonably constant protein levels.

The results of feeding trials using these materials have been submitted for publication (Disney *et al.*, 1978). A summary of the results from this paper are given in Table 7.

Dried products prepared from fish gave feed efficiencies comparable with the control diet. When silage prepared from fish allowed to spoil for 24 hours was used, growth was poor and mortalities occurred. However, a 1:1 mix of the spoiled material and control diets gave good growth and no mortalities. It would appear that silage should not be prepared from fish which is completely spoiled. The problems associated with using silage from bad fish are probably associated with thiamine deficiency as the clinical symptoms in the affected chicks were reversed by oral treatment with thiamine. It has not been established whether supplementation with thiamine would result in normal growth and further work on this aspect is needed since the effect of histamine derivatives cannot be ruled out at this stage (Disney *et al.*, 1978).

Table 7

Chick feeding trials with dried silage products

	Control diet (40 chicks)	Silage from fresh fish (20 chicks)	Silage from spoiled fish (20 chicks)	Control/silage from spoiled fish 1:1 mix (10 chicks)
Feed consumption (g per chick/3 weeks)	699.00	547.00	—	520.00
Weight gain (g per chick/3 weeks)	265.00	238.00	126.0	254.00
S E	3.9	8.3	26.8	8.9
Feed efficiency (weight feed/ liveweight gain)	2.63	2.27	—	2.04
Mortalities	—	—	10.0	—

FISH FEEDING TRIALS

Fish silage products could also be used as a feed in fish culture and the recycling of fish waste to fish could be of considerable interest in the IPFC region. Dried or moist feeds based upon silage could be used although it will be necessary to ensure that excessive quantities of soluble amino acids are not lost to the surrounding water. A programme to investigate this use has been initiated at TPI. Preliminary experiments suggest that pellets incorporating wet silage can be prepared quite easily and that formic acid does not deter the fish from feedings; detailed trials on growth rate will start shortly.

PROSPECTS FOR FISH SILAGE IN THE TROPICS

As indicated earlier, there has been a renewed interest in fish silage in recent years; this is related to the desire to reduce fish wastage. On an experimental basis, fish silage has been produced in Malawi, Bahrain, Ghana, Brunei, Hong Kong, India, New Zealand, Australia and Indonesia. In the Solomon Islands, commercial production is already in operation after a period of experimentation. While fish silage may not be the final answer to complete utilization of fish resources, the authors are confident that there are many situations in the tropics where the preparation of fish silage would be both technically and economically feasible.

The economics of silage production have been considered by Disney *et al.* (1976), Nicholson (1976) and Sumner (1976). Profitability will vary from place to place depending largely upon the cost of the raw material. In circumstances where the quantities of raw material do not warrant the capital investment required for a conventional fishmeal plant, the production of silage should be considered seriously. In the Solomon Islands silage production has been found to be far cheaper than imported meal and there is the additional benefit of reducing foreign exchange expenditure. A number of neighbouring countries have made inquiries about the possibility of importing fish silage; this provides further evidence of the commercial advantages involved. No other instances of commercial production in the tropics are known but various studies have argued in favour of the economic advantage of producing silage. As energy costs increase the economic advantages of the silage process will become increasingly apparent.

Further work is needed on fish silage, particularly in the IPFC region. The authors believe that the technology involved is now fairly well established and future research should concentrate on the utilization aspects. A number of pilot-scale production trials are required; these should be conducted alongside commercial animal production units so that the economic feasibility of the complete operation can be assessed. These trials will require active cooperation between government departments dealing with both fisheries and livestock production. Traditionally there has been little need for such cooperation and workers interested in promoting the use of fish silage will need to overcome these problems.

The technical and economic feasibility of producing silage on board fishing vessels also merits urgent attention. Sumner (1976) considered the possibilities for producing silage on board shrimping vessels but to date no trials have been carried out although it is understood that experimental trials are planned in Indonesia.

REFERENCES

- Atkinson, A., E. Lamprecht and D. Misplon, Acid and alkali preservation of fishmeal. *Annu. 1974 Rep. Dir. Fish. Ind. Res. Inst. Univ. Cape Town*, (28):44
- Bosticco, A., J. Amich-Gali and E. Tartarr, The effect of feed grade animal fat in liquid feeding for swine. *1976 Nat. Renderers Assoc., Brussels*, (122)
- Disney, J. and A. Hoffman, A dried fish silage product. Paper presented to the symposium on fish silage, Torry *1976 Research Station, Aberdeen*, 27 May, 1976, 14 p.
- Disney, J., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In Proceedings of the conference on 1977 the handling, processing and marketing of tropical fish. London, Tropical Products Institute*, pp. 237-40

Disney, J. *et al.*, Development of a fish silage/carbohydrate animal feed for use in the tropics. *Trop.Sci.*, (in press) 1978

James, D.G. and W. Krone, Developments in fish utilization. *In* Proceedings of the Conference on the handling, 1977 processing and marketing of tropical fish. London, Tropical Products Institute, pp. 467-72

Lovern, J.A., Trash fish — is there money in it? *World Fish.*, 14(7):85-6,88
1965

Nicholson, R.J.A., Economic factors affecting fish silage production in the U.K. Paper presented to the 1976 Symposium on fish silage. Torry Research Station, Aberdeen, 27 May, 1976

Peterson, H., Acid preservation of fish and fish offal. *FAO Fish.Bull.*, 6(1-2):18-26
1953

Smith, P and A.H. Adamson, Pig feeding trials with white fish and herring liquid protein (fish silage). Paper 1976 presented to the Symposium on fish silage. Torry Research Station, Aberdeen, 27 May 1976

Sumner, J., A feasibility study for fish silage production in the IPFC region. Paper presented to the IPFC Working 1976 Party on Fish Technology and Marketing Sri Lanka, October 1976, IPFC FT/76/4

PERFORMANCE OF PIGS FED ON DIETS CONTAINING FISH SILAGE:
EVALUATION IN THE COMMERCIAL SITUATION

by

J. Sumner

Department of Veterinary Science, Lincoln College
Canterbury, New Zealand

Abstract

The feasibility of feeding various diets containing fish silage (barracouta, *Thyrsites atun*) to Large White Landrace pigs has been evaluated. Three trials were carried out. A diet of barley (67): silage (33) led to poor weight gains through the 'condition' of the silage-fed pigs was superior to the control group. In Trial 2 the inferior weight gain was eliminated by feeding a larger volume of silage-based feed (120 percent as fed). In the third trial silage was used as supplement (10 percent) together with barley (75 percent) and blood and bone meal (15 percent); the farmer commented favourably on the good condition of silage-fed pigs, as well as the increased palatability of silage feeds coupled with the elimination of the dust problem normal on pig farms feeding a dry meal.

Against the positive aspects of silage diets must be balanced the fact that in Trial 1, three pigs were considered by consumers to have a fishy taint.

INTRODUCTION

While fish silage has been fed to pigs in Denmark and Poland for several decades, it is only in very recent times that other countries have considered its use. The major drawback in the use of silage, from the pig farmers' viewpoint, has been the possibility that fish oil in the silage would result in pork which had an undesirable fishy taint. The recent work, however, of Hillyer *et al.* (1976) and Smith and Adamson (1976) showed, in closely supervised experiments, that silage could be fed at specific levels in the diet without the resulting carcasses being contaminated. Of obvious interest was whether these 'experimental' findings could be duplicated on the farm; the results of three trials are reported here.

EXPERIMENTAL

Silage

The fish silage employed throughout was made from barracouta (*Thyrsites atun*) and formic acid; no problems were encountered with mould growth although the silage was stored for several weeks. The lipid content was 3.3 percent.

Pig feed

The pig farm was set up for feeding dry meals so that the silage was mixed with the barley base in a hopper through which ran an auger. The barley/silage feed was sufficiently dry to enable the normal method of feeding; merely ladling the feed onto the floor of each pen.

All fattening stock on the pig farm were Large White Landrace Crosses

Feeding trials

Three feeding trials were carried out. The diets used are shown in Table 1. To all silage-based diets was added a chemical premix of vitamins, minerals and trace elements (Jones and Hoskins, Pig Grower Premix). This additive was excluded from the control diet which contained 'Superblend' (Northern Rolling Mills, Ltd.).

Grading

At the abattoir, the carcasses were graded by meat inspectors into three categories (1st, 2nd or 3rd).

Table 1

Diets used in the feeding trials

Trial	Silage (%)		Control (%)	
1	Barley	67	Barley	84
	Fish silage	33	'Superblend'	16
2 ^{a/}	Barley	67	As Trial 1	
	Fish silage	33		
3	Barley	75	As Trial 1	
	Fish silage	10		
	Blood and bone meal	15		

a/ The quantity of silage diet fed was increased by 20 percent (120 percent)

RESULT AND DISCUSSION

The silage-based diets were accepted enthusiastically by the young weaners. In Trial 1, however, the weight gain of silage-fed pigs was inferior to the control group, though in other respects, cost of live-weight gain and also 'condition', the silage-fed group was superior (Table 2).

Table 2

Performance of pigs fed on a diet containing fish silage, Trial 1
(Barley 67 percent: Silage 33 percent)

	Silage	Control
Average daily gain (kg)	0.479	0.562
Cost of live-weight ^{a/} gain (cents/kg)	34.42	37.89
Grading: First	11	11
Second	1	1

a/ N.Z.\$ 1 = U.S.\$ 0.98 (April, 1978)

In Trial 2 the pig farmer attempted to ameliorate the poor weight gain by increasing the quantity of feed supplied; the diet was retained but was fed in 20 percent greater quantity. All the feed was accepted and the live-weight gain was equal to that of the control group. Because of increases in conventional stock feeds the 'Superblend' had increased in price, making the silage diet still superior on the basis of cost/live-weight gain. The somewhat inferior grading of silage-fed pigs was not considered important by the pig farmer (Table 3).

In Trial 1, which was still proceeding when Trial 2 was begun, the silage-fed pigs was distributed to staff of the pig farm, three of whom complained of a fishy taint after cooking the pork. The pigs from Trial 2 were distributed through the usual retailing system; no complaints of taint were received.

Because of the complaints of fishy taint for the carcasses in Trial 1, a third trial was carried out in which silage was used as a supplement at the 10 percent level, the protein content being maintained by using blood and bone meal. Although the weight gain was inferior the farmer considered the silage diet still attractive for four reasons: enhanced palatability, superior cost of live-weight gain, better 'condition' of stock and a reduction in the dust problem encountered in feeding dry meals (Table 4).

Table 3

Performance of pigs fed on a diet containing fish silage, Trial 2
(Barley 67 percent: Silage 33 percent, whole ration increased
by 20 percent compared with Trial 1; i.e., 120 percent as fed)

	Silage	Control
Average daily gain (kg)	0.594	0.588
Cost of live-weight gain (cents/kg) ^{a/}	36.53	45.05
Grading: First	6	10
Second	7	14
Third	2	0 ^{b/}

a/ N.Z. \$ 1 = U.S. \$ 0.98 (April, 1978)

b/ One pig from the control group died during transport
to the abattoir: reasons unknown

Table 4

Performance of pigs fed on a diet containing fish silage, Trial 3
(Barley 75 percent: Silage 10 percent: Blood and bone meal 15 percent)

	Silage	Control
Average daily gain (kg)	0.51	0.58
Cost of live-weight gain (cents/kg) ^{a/}	34.6	42.0
Grading: First	17	18
Second	8	6
Third	0	0

a/ N.Z.\$ 1 = U.S.\$ 0.98 (April, 1978)

Although the pig farmer was satisfied with the fish silage diets there were a number of problems encountered; firstly, with the silage itself. In Trial 1 low weight gains were recorded even though the diet used had proved acceptable in experimental trials carried out in the United Kingdom (Smith, 1977 personal communication). Among the reasons suggested for the low weight gain were that the dry matter content of the silage varied and was sometimes less than the 'accepted' level of 20 percent; that during addition of the silage to the barley the barrels of silage were not agitated resulting in a 'thin' silage because the solids settled out.

Staff on the pig farm encountered difficulties with mixing the silage. When added at the top of the hopper, the silage tended to coat the sides rather than mix with the barley. Also, silage adhered the auger, involving staff in additional cleaning duties. Another staff member found a cut became septic while working with silage.

After complaints of taint had been received the lipid content of the silage was found to be 5.5 percent, as opposed to 3.3 percent in the batch used at the beginning of the experiment; a fact which indicated the necessity of analysing the lipid content of each batch of silage as well as the dry matter content.

The problem of taint is one which must be resolved in order that pig farmers can use silage with confidence. The evidence of the level at which silage in the food results in taint in the pork is conflicting. In the U.K., experimental data suggest that silage containing 3.6 percent oil does not lead to taint when pigs are fed a diet of 33 percent silage (Smith and Adamson, 1976).

In Poland, however, where silage is a common part of pig diets the problem of taint is regarded as a serious one, the oil is removed by centrifugation to a level below 1 percent. The Central Laboratory, Gdynia, Poland has also developed a method of fat stabilization if centrifugation is not possible, the technology of silage production being covered by patents Nos. 42729, 46775, 53520 and 54360 in the Polish Patent Office. Fish silage is also eliminated from the diet about six weeks before slaughter (Majewski, Central Laboratory, personal communication).

On the other hand, since taint is biochemical, it is doubtful whether a withdrawal period of six weeks would be sufficient to eliminate all trace of taint. Prejudices with pork are not uncommon; for example, many consumers regard boar meat unfavourably because of bear taint. However, recent doubleblind experiments carried out by the New Zealand Pork Industry Council revealed that this boar meat could be sold without complaint providing the consumer did not know he/she was eating boar meat. On the other hand when consumers were led to believe they may be eating boar meat there were many complaints even when boar meat had not been sold (Adam, Ministry of Agriculture, Ruakura, New Zealand, personal communication).

Similarly with pork produced from pigs fed fish silage, people can 'taste' fish as soon as they may suspect that the animals' diet may have contained fish even to the extent of complaining about fishy taint in animals fed the control diet (Smith, personal communication). A key factor in marketing pork from pigs fed silage-based diets is the slaughtermen at the abattoir since they become aware of fishy odours from the gut contents. It is necessary, therefore, to feed conventional meal on the last day or two before slaughter so that the gut contents appear normal.

It is clear that using silage as a sole protein source at a level, for example, of 33 percent of diet, will involve a basic quality control plan in which each batch is assayed routinely for oil content, dry matter content and protein content. Ideally, almost all the oil should be removed so that the pig farmer could have absolute confidence in the product and at the same time freeing the oil for incorporation into petfood, for which fish oil currently commands a price of N.Z.\$ 450/tonne. If oil separation equipment is not available, however, the batches of silage should be divided on the basis of oil content into two categories. 'Low' oil silage of less than 3.0 percent oil could be used for fattening diets while 'high' oil silage (above 3.0 percent) could be used exclusively for breeder stock.

ACKNOWLEDGEMENTS

The author is grateful to Mr. H. Shadbolt and Mr. C. Shadbolt, Independent Fisheries, Ltd., Christchurch; Mr. P. Powlesland, New Zealand Pork Industry Council and Mr. D. Glass for access to the data compiled on his pig farm during the feeding trials.

REFERENCES

- Hillyer, G.M. *et al.*, Evaluation for on-farm use of de-oiled herring silage as a protein feed for growing pigs. Paper 1976 presented to the Symposium of fish silage. Torry Research Station, Aberdeen, 27 May 1976
- Smith, P. and A.H. Adamson, Pig feeding trials with white fish and herring liquid protein (fish silage). Paper 1976 presented to the Symposium on fish silage, Torry Research Station, Aberdeen, 27 May 1976

PREPARATION OF PROTEIN CONCENTRATES FROM WASTE FISH

by

R.G. Poulter and J.G. Disney
Tropical Products Institute
London, U.K.

Abstract

The development of a simple low-cost process for the manufacture of dried salted fish minces and cakes from waste fish is described and trials to determine the acceptability and keeping quality of the products are reported. Possible solutions to the problems of preservation prior to processing, limiting the degree of rancidity in the final product and controlling bacteriological quality are suggested. The merits of dried salted minces and cakes are considered in relation to other types of fish concentrates.

INTRODUCTION

During the sixties, intensive efforts were made to develop and introduce powdered fish products which had a very high protein content and were suitable for mass feeding to the malnourished populations of the developing world. The main effort took place in the United States and Canada and was concerned with developing a tasteless, colourless and odourless powder with a low fat content. This product came to be known as FPC type A. The philosophy behind this approach was that such a product would be used to fortify familiar foods without changing their organoleptic properties. Unfortunately FPC type A did not live up to its expectations and commercial production did not materialize although similar products, but with functional properties, have been developed and are in use in sophisticated markets. A number of reasons have been proposed for the failure of FPC type A as a means of providing protein to developing countries (Finch, 1977; Halliday and Disney, 1972). Raw material and production costs were considerably higher than original estimates and problems were experienced in introducing the product into developing countries, particularly regarding acceptability.

In the early seventies technologists paid relatively little attention to the problem of producing protein concentrates. In recent years, however, there has been a renewed interest related to the growing desire to improve the utilization of marine resources.

In many developed countries there is a growing concern over dwindling fish stocks. In the tropics the situation is less critical but considerable attention is being directed toward nonconventional and underutilized resources.

Of the conventional fish resources, two major underutilized groups may be identified. Firstly, large quantities of fish are discarded at sea because it is currently uneconomic to preserve and bring them ashore. Shrimp by-catch is the best known example of such fish and, based upon a 5:1 ratio of fish to shrimp and a million-tonne global shrimp catch, the quantity of by-catch wasted annually is around 5 million tonnes (FAO, 1975). Secondly, large quantities of marine resources are wasted in the sense that they are unutilized or underutilized. Potential fish resources, as seen by FAO (James and Krone, 1977), include something in the order of 25 million tonnes of small pelagic fish which occur largely in tropical waters but which are as yet not caught. Some of the 17 million tonnes of small pelagic fish currently used for reduction to meal could also be used for human consumption. Perhaps the largest potential source of fish for production of protein concentrates are the nonconventional groups such as cephalopods, mesopelagic fish and krill. It has been estimated that a catch upward of 160 million tonnes of these unconventional species could be taken annually (FAO, 1975). At present the main problems with these fish are concerned with 'catching' technology. The role of the food technologist to ensure that they are fully utilized when landed will come at a later stage.

Although the accent on improved utilization is universal, the method of approach varies with the degree of sophistication in the market to be supplied. In the more developed countries, research has been directed toward developing bland tasting protein concentrates with functional properties whereas technologists interested in the utilization of fish in the developing countries, generally concentrate upon relatively small-scale processes which use unsophisticated methods. The latter approach forms the basis of this paper. The various avenues open to the technologist are briefly reviewed and then the preparation of salted/dried fish products is considered in more detail in line with the activities of the authors.

ALTERNATIVE APPROACHES TO IMPROVED UTILIZATION

The development of products from unutilized or underutilized resources should concentrate firstly on the application of existing technology and preservation by conventional processes. For example, there will be many situations where, given sufficient equipment and services, a new resource can be sold as fresh, frozen, canned or cured fish. Salted, dried or smoked products have particular advantages since they are prepared at relatively little cost and are very acceptable in many developing countries. Only where technical or economic factors prohibit the adoption of such methods should novel methods be applied.

Unfortunately, all too often, the underutilized resources do not lend themselves to utilization by conventional approaches. A brief consideration of shrimp by-catch and small pelagic fish will serve to illustrate this point. In shrimping operations, the most economic method of disposal of the fish by-catch from the vessel operators' point of view is simply to discard the fish. Factors arguing against the landing of the shrimp by-catch are the low market value of the material, the size and species composition (some 20-50 species may be involved which would require considerable sorting), the lack of suitable refrigerated storage space on board and the possible reduction in shrimping efficiency. Shrimp fisheries exist in many parts of the world and, although the vessels vary in type and design, most exhibit a common problem of landing and preserving the fish alongside the shrimp. This problem has been considered in a number of reviews (Meinke, 1974, Allsopp, 1977). In some countries, e.g., Guyana and Indonesia, mandatory steps have been taken to force shrimp vessels to bring ashore at least part of the by-catch as a means of providing locally needed fish supplies. Up to now, attempts have generally failed on economic grounds since the value of the catch is insufficient to justify the expenditure involved in preservation on board the vessel. Nevertheless, it is widely accepted that this waste cannot continue and attempts are being made to develop methods which are both economically and technically feasible. For example, trials are about to be conducted in Guyana on transference at sea of the by-catch from the shrimp vessel to a mother vessel. The aim is to handle the by-catch from a considerable part of the fleet, preserve it and bring it ashore for local consumption.

The major problem with small pelagic fish is the seasonal nature of the fishery. In south-west India, for example, large stocks of small pelagic fish are known to occur at limited times during the year. The value of these fish is insufficient to justify the large-scale capital investment in fishing vessels which for the remainder of the year would be unused. Trials are underway to determine means of capturing such fish in the season with vessels which are suitably equipped to carry out other forms of fishing during the remainder of the year. Such multipurpose vessels may overcome at least one of the problems associated with utilizing this resource.

There are also processing problems with by-catch and small pelagics; the former because of the size variation and species mix and the latter because of their high fat content. However, both forms of raw material could be converted into fermented sauces or pastes. There are many fermented fish products in South East Asia which play an important role in the local food complex (Amano, 1962; Van Veen, 1965). Their manufacturing processes have been developed over long periods to suit the climatic conditions and specific market demands. The level of technology used for these traditional processes varies but they are all based on the proteolytic action of enzymes originating from the fish, from the developing microflora or from both. Studies have been made in several countries to increase the efficiency of the process and to improve the protein quality of these products. In the Philippines, for example, there is apparently very little wastage because even the smallest unwanted species are converted into 'bagoong' (Van Veen, 1965). Similar products have also been introduced into Africa and Faubau

(1977) has advocated this technology as a means of utilizing waste fish throughout the tropics. The potential for such products may, however, be limited (FAO, 1975).

FPC type A failed mainly because high raw material costs on top of high processing costs rendered the process uneconomic. Furthermore, the bland flavour of the product was disliked in many developing countries. FPC type B on the other hand may stand a better chance of becoming widely used. The product which has been most investigated to date is a Norwegian product called 'Norse Fish Powder' (Norseldmel, Bergen, Norway). It is grey/brown in colour with a smell and taste of fish and contains up to 10 percent fat. In principle, the method of manufacture is similar to that used in ordinary fishmeal and oil production but with special requirements for freshness and quality of raw materials, a food industry standard for plant and processing hygiene, mild drying conditions and a strict microbiological requirement for the end product. Since no costly solvent extraction procedures are required, the processing costs are greatly reduced as compared with FPC type A. The acceptability of the product has been tested in West Africa and parts of Asia. In general the product was acceptable in countries whose populations have a diet which includes dried or salted fish, either as an ingredient or as a condiment, but was rejected in other countries (Tagle *et al.*, 1977). Material for testing has so far been produced experimentally using specially cleaned fishmeal plants. Recently a plant specifically designed to produce FPC type B has been completed and future developments are awaited with interest (Day, 1977).

In the more developed countries, the high cost of popular food has resulted in considerable efforts being expended to develop processes for recovering and utilizing fish flesh for human food. The most important development is the meat/bone separator which has enabled, at relatively little cost, up to 10 percent extra flesh to be recovered from fish frames. A large international trade in frozen minced blocks has developed for use in the production of fish balls, fingers, etc. This technology is being applied, at the research level, to the problem of improved utilization of fish in developing countries and some of the results will be reported at this Symposium.

In line with the desire to develop low-cost simple technology products, several workers have attempted to combine a number of the processes referred to above.

Steinberg *et al.* (1977) recognized the magnitude of the technological and economic problems associated with making underutilized species marketable in traditional forms and decided that they should be considered as a food commodity that required relatively low-cost processing to put them into forms suitable for use as ingredients in other foods. Their approach was to develop techniques for drum drying whole fish muscle and mixtures of fish muscle and cereals. The process consists of mechanically deboning headed and gutted fish, mixing in 0.5 percent NaCl and 2 percent tripolyphosphate and applying the mixture directly onto the drum dryer. Drying problems were not serious provided the oil content did not exceed 2 percent. The final moisture content was 5-8 percent. Drying fish together with cereals had advantages since if a minimum of 10 percent cereals was used then the addition of NaCl and polyphosphates was not necessary. Although not stated by the authors, presumably if cereals are added, fish with a higher fat content could be utilized since the fat will be 'diluted' by the cereals. The main use of drum-dried fish in the U.S.A. is in Frankfurter sausages and similar products but the process could have applications in the developing world (Steinberg *et al.*, 1977).

Salted fish is an integral part of the diet in many developing countries. In traditional techniques the salting operation takes several days to complete and during the early stages there is insufficient salt to prevent spoilage. The need for a more efficient technique to rapidly salt fish was recognized by Del Valle and co-workers (Del Valle and Nickerson, 1968; Del Valle, 1974) who developed a method in which minced fish was mixed with sufficient salt to denature the proteins, the water thus released was pressed out and the press cake sun-dried. The technique was designed for use in developing countries and, as such, required little processing equipment. The process was subsequently adopted by several other workers. Anderson and Mendelsohn (1972) and Bligh (1977), using a similar process and more sophisticated equipment, made a blander product more akin to the taste of the western countries but which has been the subject of acceptability trials by the World Food Programme in the tropics. This type of product has considerable potential in the tropics if it can be made from more oily fish, the current product being made from species of low fat content.

In our own laboratories and overseas programmes we are attempting to develop a salted/dried fish powder using processing methods which could be applied at the village level in the tropics. The problems are enormous particularly when fish with high oil contents are to be used. Some of these problems, together with an indication of the progress so far, are considered below.

PREPARATION OF SALTED/DRIED FISH PROTEIN CONCENTRATES

The basic process for the production of salted/dried fish cakes and powders is given in Fig. 1.

TPI work carried out in Malawi (Poulter, unpublished) and Mexico (Young, unpublished) has shown the importance of using good quality fish as the raw material for the process. These workers found that small fish stored at ambient temperatures for 8-10 hours with little or no ice were semi-spoiled and were not suitable for the production of salted fish cakes since the gelling properties of the muscle proteins had been severely diminished. Not only does the use of semi-spoiled fish present processing problems but there is also a potential health hazard due to the presence of toxic bacterial metabolites.

The need to preserve the fish from the time of capture until processing on shore by the use of ice or refrigeration could be eliminated if the process for the production of salted fish concentrates could be started on board the fishing boat. Production of fish sillage for animal feed and fish hydrolysates for human food on board fishing boats has been contemplated by several workers (Sumner, 1976; Pigott, (personal communication)). The initial steps in the production of salted fish protein concentrates (i.e., mincing and salting) could also be undertaken on board provided strict standards of hygiene could be complied with.

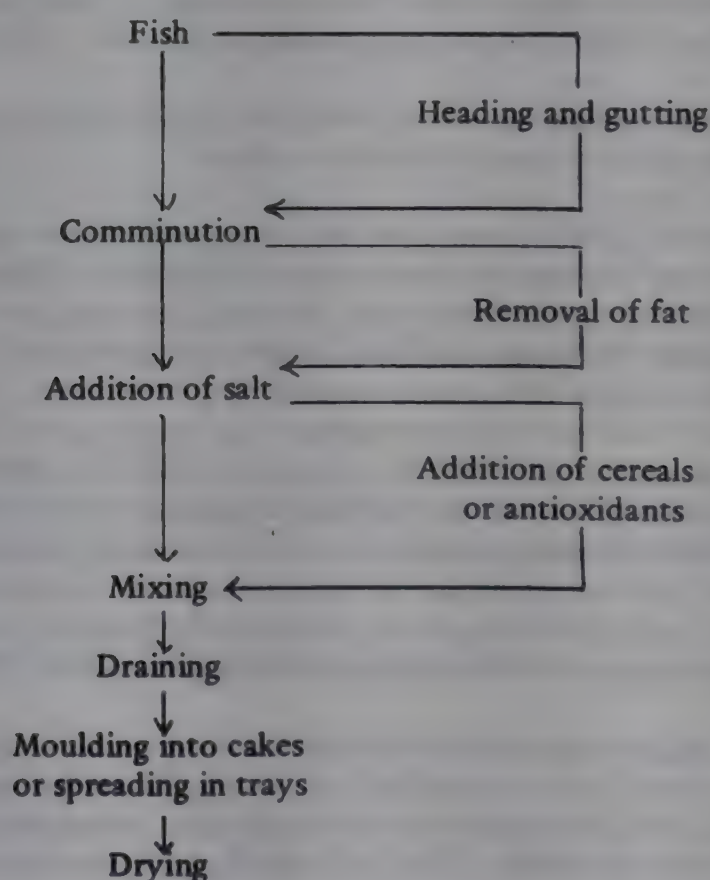


Figure 1 Method for the preparation of salted/dried fish cakes and powders

Mills are available which can grind whole fish. The end product, however, has a very small particle size and, being very liquid, is difficult to handle. Simple mincing machines yield fish minces with a consistency more suitable for the production of salted/dried products. Electric mincers comminute very small fish or fish with relative-

ly soft bones without problems but fish with stronger bones clog even quite powerful mincers. In experiments carried out in Malawi (Poulter, unpublished) this problem was overcome by partial cooking of the fish. Excess cooking is to be avoided since it completely denatures the flesh and renders it impossible to mould into cakes. In Malawi, using fish of 6-60 g in weight, the optimum cooking time in boiling water was about 5 minutes.

For operations other than at the village level, a meat/bone separator is probably the most appropriate method of comminution and a variety of different types are available (King *et al.*, 1972). For the production of salted fish concentrates the rotary belt and drum type appear to be better than the drum and internal screw type (Young, personal communication). In preparing fish for the production of salted products the problem of removal (or inclusion) of the offal arises. Fish heads are consumed in many parts of the world but they impart a dark colour to mechanically separated fish minces. Fish guts also contain many pigmented compounds and in many cases are very fatty. Thus, they may also affect the appearance of the mince and impart a bitter taste. Furthermore, there are health problems due to the possible presence of pathogenic bacteria and toxic compounds in the fish guts. There is therefore a great advantage in removing the heads and guts of trash fish before comminution. On a small scale it may be possible to do this manually but on an industrial scale, if the heads and guts are to be removed, it will have to be done mechanically. As yet there is little or no equipment available which is capable of heading and gutting fish which vary in shape and size. This in effect rules out the heading and gutting of fish by-catch because such trash fish contains a great variety of fish types and species. Even where large quantities of standard sized fish occur (e.g., pelagic species) equipment is not available at a price which allows the process to be economic. This represents one of the more serious constraints to the utilization of trash fish; a cheap and effective means of heading and gutting fish is badly needed.

As far as technological advances are concerned, what is also required is a cheaper, less sophisticated type of meat/bone separator suitable for use at the artisanal level. It should be possible to develop a hand or bicycle powered meat/bone separator at a cost much lower than the electric machines currently available.

Instead of completely disintegrating fish muscle by some form of mincing, it has been suggested that preparation of fish chunks would have advantages (James, personal communication). The chopping operation could be undertaken by hand or by a simple machine. The salt penetration and drying rates in the chunked fish would be faster than for whole fish and the advantage over mincing would be that it may be possible to shake and/or wash out the guts, blood, etc. Further, acceptability and marketing problems with chunked fish may be less than with powders or cakes since they retain the physical appearance of fish. The Tropical Products Institute is currently undertaking trials on the production of salted fish chunks.

The purpose of adding salt to fish minces is two-fold. Firstly, it reduces the water activity of the mince which enhances its keeping quality and secondly, if added in sufficient quantity, it denatures the muscle proteins, diminishes their water-holding capacity and facilitates the loss of water during the drying process. The physical characteristics and storage stability of the final product are largely dependent on the concentration of salt added to the wet mince (these aspects of salt addition will be covered in a later section of the paper).

It is important that salt is distributed evenly through the fish mince. When a mincer is used to comminute fish flesh, this can be achieved simply by mincing the fish and salt together. This method has been used successfully in Malawi (Meynell, unpublished) to produce salted/dried fish cakes from waste fish resulting from commercial filleting operations. If other methods of comminution are used, mixing of salt into the mince can be done by hand but there are obvious advantages in the use of mechanical mincers.

Addition of salt to minced fish muscle releases some of the water bound to the proteins. In order to reduce drying times, as much as possible of this water should be expelled before subjecting the material to the drying process. This can be done by decanting, pressing or draining through cheese-cloth.

The salted and drained fish mince can be dried either as thin layers in trays or in the form of cakes moulded using a hand-operated hamburger press. In the absence of a commercially produced press, a simple home-made one can be constructed using thin sheets of aluminum (Meynell, personal communication).

The drying operation can be undertaken using a mechanical dryer, a solar dryer or by sun-drying (Poulter and Disney, 1977; Meynell, unpublished). At the village level, sun-drying would be the most economical method provided that the climatic conditions are suitable. Many tropical countries suffer from periods of high rainfall and during these periods sun-drying would not be possible. In Malawi (Poulter, unpublished) a non-mechanical kiln of the Ivory Coast type has been used during these periods to produce a smoked/dried product.

PRODUCT CHARACTERISTICS AND STORAGE STABILITY

Microbiological growth is completely arrested in a product if the water activity is 0.6 or lower (Mossel, 1975). Table 1 shows the total viable counts of bacteria in wet chambo (*Tilapia lidole*) minces and in cakes immediately after drying and after 6 months of storage at ambient temperatures (20°-25°C). The cakes were made in the laboratory by adding 5, 10, 15 and 20 percent salt to minces obtained by passing headed and gutted fish through a Baader 694 meat/bone separator, pressing in a hand-operated hamburger press and drying in a forced draught kiln at 35°C.

Table 1

Total viable counts of bacteria in salted/dried fish products during storage

Sample	Time of storage (months)	Total viable counts of bacteria per g.			
		Chambo (<i>Tilapia lidole</i>)	Chisawasawa (<i>Lethrinops</i> spp.)		
		Cakes salted/dried	Cakes salted/dried	Cakes salted/smoked	Powder salted/dried
Wet mince		4.8×10^3	—	—	—
Dried/salted ^{a/} products					
5 % salt		3.4×10^5	—	—	3.0×10^7
7.5 % salt		—	9.8×10^4	2.3×10^5	—
10 % salt	0	1.6×10^3	—	—	—
15 % salt		4.8×10^3	—	—	—
20 % salt		1.5×10^3	—	—	—
5 % salt		—	—	—	9.0×10^1
7.5 % salt		—	4.4×10^2	3.0×10^2	—
10 % salt	3	—	—	—	—
15 % salt		—	—	—	—
20 % salt		—	—	—	—
5 % salt		3.0×10^1	—	—	2.9×10^3
7.5 % salt		—	1.6×10^2	1.5×10^2	—
10 % salt	6	7.5×10^1	—	—	—
15 % salt		6.0×10^1	—	—	—
20 % salt		1.0×10^2	—	—	—

a/ Salt content refers to that added to the mince

The results show that a concentration of salt greater than 5 percent prevented an increase in bacterial numbers during pressing and drying. Further, in all the cakes studied the total viable counts decreased during storage. This is in agreement with the findings of Del Valle *et al.* (1973).

A more detailed microbiological analysis of the cakes after 6 months of storage showed that there were no *Salmonella* spp. (per 50 g), no coagulase-positive staphylococci (per 1 g), no *Clostridium* spp. (per 2 g), no *Vibrio* spp. (per 25 g), the most probable number of coliforms was 0 and the salt-tolerant bacteria (i.e., growing on agar containing 5 and 30 percent salt) were less than 300/g.

Also shown in Table 1 are the total viable counts of bacteria in salted/dried cakes and powders made from chisawasawa (a mixture of *Lethrinops* spp. caught in Lake Malawi). They were produced in Malawi under field conditions as follows: headed and gutted fish were cooked in an oil drum over a wood fire for 5 minutes, minced together with 7.5 percent salt, pressed into cakes using a home-made press and sun-dried (temperature 25°C-35°C or smoke dried in an Ivory Coast kiln using palm nuts as fuel. The salted/dried powder was also produced in the same way except that 5 percent salt was added and the mince sun-dried as thin layers in trays.

Although they were made under field conditions where it is difficult to maintain high levels of hygiene, the bacterial counts of these products were similar to cakes made under laboratory conditions and, again, there were no pathogenic organisms and only low numbers of halophiles present.

The addition of salt in concentrations greater than 5 percent is therefore sufficient to prevent microbiological spoilage provided the cakes are dried to a water content of 30 percent or less. However, Duerr and Dyer (1952) and Fougere (1952) found that, in order to destroy the water-holding capacity of fish muscle, salt concentrations in excess of 10 percent are required. Table 2 gives the appearance and texture and Table 3 the proximate composition of fish cakes made from chambo minces to which 5, 10, 15 and 20 percent salt had been added. The results show that in minces containing up to 10 percent salt the proteins retain their water-holding capacity and in fact salt increases this property. These minces dry slowly and the cakes have an appearance of a shrunken gel. On the other hand, if the salt concentration in the mince is 15 percent or above, the proteins start to denature and lose their water-holding capacity. The cakes therefore dry more rapidly and the final cake has an open texture; an advantage in that it facilitates desalting (see Table 4). Wojtowicz *et al.*, (1977) recommended the use of 25 percent salt for the production of salted minced cod. They found that this concentration of salt gave them the greatest separation of water from the fish muscle. For the production of fish cakes, if the gelling capacity of the muscle is completely destroyed by adding such high concentrations of salt, it is not possible to form cakes using a hand press. The optimum concentration of salt for the production of fish cakes from raw fish minces is therefore in the region of 15 percent.

The characteristics of salted/dried fish cakes made from partly cooked minced fish are different from those made from uncooked minces. The appearance and chemical composition of cakes made from partly cooked chisawasawa minces with 5, 10, 15 and 20 percent added salt are shown in Tables 2 and 3. Cooking partly destroyed the gelling capacity (i.e., denatured the proteins) of the wet mince and addition of salt had little effect as far as the physical properties of the proteins were concerned. Salt did, however, have the effect of 'holding' water in the cake and as the salt content of the cakes increased so did the drying rate and final water content. All the cakes had a 'close' texture and the softness reported in the cakes made from minces with 15 and 20 percent added salt was due to a high water content rather than to an open texture. Hence with partly cooked fish minces containing approximately 70 percent water, cakes with the best drying rates and textural characteristics are obtained when between 5 and 10 percent salt is added.

To the western palate even a mild degree of rancidity renders a fishery product unacceptable. In developing countries the staple diet is often bland consisting mainly of carbohydrates. The protein and 'taste' of the meal is obtained through the relish eaten with the carbohydrate. One of the ways in which salted/dried fishery products could be introduced into such a diet is by adding them to the relish. For use in this way there are two pertinent points. Firstly, a slightly rancid flavour in salted fish is an advantage since the relish is, in effect, used as a condiment to add spice to the main dish. Secondly, the amount of fish that is consumed in any one meal is quite low

and hence a high degree of oxidation of the fats has to occur before problems due to toxicity will result. Lovern (1965) suggested that consuming 2 g of rancid fat, i.e., 20 g of rancid FPC containing 10 percent fat, would be unlikely to involve any significant health risk. He did, however, point out that experiments in which the Indian population of Peru were offered dried whole anchovies had to be abandoned because the fish were consumed with such relish (despite or because of the rancidity) that illness resulted.

Table 2
Appearance and texture of salt/fish cakes

Salt/cake ^{a/}	After pressing	After drying
<i>(a) Cakes made from uncooked chambo minces</i>		
5% salt	Gelatinous/fleshy No drip	Dense shrunken gel Leathery texture
10% salt	Gelatinous/fleshy No drip	Shrunken gel Firm/close texture
15% salt	Slightly crumbly Some drip	Little shrinkage Firm/open texture
20% salt	Crumbly Much drip	No shrinkage Brittle/open texture
<i>(b) Cakes made from partly cooked chisawasawa minces</i>		
5% salt	Thick paste No drip	Slight shrinkage Firm/close texture
10% salt	Thick paste No drip	No shrinkage Firm/close texture
15% salt	Thick paste No drip	No shrinkage Soft/close texture
20% salt	Thick paste No drip	No shrinkage Soft/close texture

a/ Salt content refers to that added to the mince

Table 3

Composition of samples

	Water % (w/w)	Salt % (w/w)	Crude fat % (w/w)	Crude protein % (w/w)	Ash % (w/w)
<i>Uncooked chambo mince and salt/cakes</i>					
Mince	74.4	—	4.0	18.7	1.4
<i>Dried/salted^{a/} cakes</i>					
5% salt	19.1	16.3	11.1	48.6	—
10% salt	27.4	20.9	9.9	42.3	—
15% salt	6.2	35.7	11.4	43.1	—
20% salt	3.6	40.9	10.7	41.3	—
<i>Partly cooked shisawasawa mince and salt/cakes</i>					
Mince	71.7	—	3.3	20.4	4.3
<i>Dried/salted^{a/} cakes</i>					
5% salt	7.0	12.8	—	—	—
10% salt	6.1	26.9	—	—	—
15% salt	30.2	21.9	—	—	—
20% salt	40.7	32.7	—	—	—

a/ Salt content refers to that added to the mince

Table 4

Salt content of salt/chambo cakes before and after desalting

Dried salt/cake ^{a/}	(Salt % dry weight)		% Salt removed
	Before	After	
5% salt	17.6	10.6	39.8
10% salt	30.0	13.5	55.0
15% salt	36.6	4.5	87.7
20% salt	43.7	2.9	95.4

a/ Salt content refers to that added to the mince

In salted/dried fish concentrates it is, therefore, necessary to reduce the fat content and/or limit the extent to which they become oxidized. In FPC type A production this involved expensive fat extraction procedures and this was one of the factors contributing to the failure of this product. Simple water-washing procedures may on the other hand be more useful. Spinelli *et al.* (1977) have incorporated a dilute salt-washing step into their drum drying process for fish minces. Although in this case the aim was to remove the sarcoplasmic proteins (mainly enzymes) and thus produce a more stable product, a similar process could be used to extract fat. Preliminary studies at the Tropical Products Institute have been undertaken with fatty fish such as chisawasawa (*Lethrinops* spp.) which can have up to 18 percent fat in the flesh. When two parts of water were mixed with one part of comminuted fish and the mixture allowed to settle, three layers were obtained. The top layer was fat, the second layer contained the sarcoplasmic proteins and some suspended solids and the bottom layer contained mainly the myofibrillar proteins. After removal of the fat and aqueous layers the solids were drained through cheesecloth, salted and dried. The results of these preliminary studies showed that a single washing removed up to 35 percent of the fat (Crean, unpublished). Experiments are currently being conducted to determine the relationship between the number of washes, the loss of fat and the level of recovery (the loss of soluble proteins and suspended solids). Although this procedure will never reduce the fat content to that achieved by solvent extraction, if the fat content of the final dried product can be limited to 10 percent, this will be acceptable.

The addition of antioxidants to salted fish products is another way of controlling the degree of rancidity. Work at TPI has shown that addition of 0.02 percent butyl hydroxy toluene (BHT) to salted/dried fish cakes containing 7 percent fat resulted in 50 percent less rancidity (as measured by TBA number) occurring during 6 months of storage at 25°-30°C. Current TPI work (Crean, unpublished) has shown that even lower concentrations of BHT (e.g., 0.006 percent) are effective in reducing rancidity in salted/dried mackerel cakes. Furthermore, Canadian workers have demonstrated that tertiary butylhydroquinone (TBHQ) is the most powerful antioxidant for unsaturated marine lipids (Ke *et al.*, 1977) and it is hoped in the near future to test this compound with salted fish products.

The addition of artificial antioxidants to fish products will add to their cost and there is also concern at present over the possible toxicity of some antioxidants. In many developing countries spices with natural antioxidant properties are relatively cheap and easily obtained (Chipault *et al.*, 1956). Fermented soy extracts, e.g., tempeh oil, have also been found to have antioxidant properties. The addition of such compounds may therefore allow control of rancidity without the need for expensive commercially produced antioxidants.

Common salt has been said to have a pro-oxidant effect (Watts, 1962) but this is probably a result of metal contamination of the salt rather than a property of sodium chloride itself. Careful control of the quality of the salt used in the production of salted fish products may therefore go some way to reduce the degree of rancidity.

The production of salted fish products with an added carbohydrate material is a further way of modifying their physical characteristics and storage stability. For salted/dried fish cakes, for example, up to 15 percent maize or cassava meal may be added without seriously affecting their cohesive properties (Poulter, unpublished). Not only does this produce a cake with more balanced nutritional properties but also it effectively 'dilutes' the fat content and lightens the colour. The latter may be a great advantage particularly if the cakes are derived from whole fish minces which are very dark in colour.

The type of carbohydrate to be added to the salted fish product will depend on the local availability and the preference of the consumer. In the Seychelles high organoleptic ratings were obtained with fish cakes to which sweet potato had been added (Hoffman, unpublished). In Mexico a protein-enriched flour, produced by adding a salted/dried fish powder to maize meal, was found to be highly acceptable when made into tortillas (Young, unpublished). Whereas in Malawi, trials in which low concentrations of salted fish minces were used to fortify wheat flour for bread production showed promise (Poulter, unpublished).

CONCLUSIONS

The production of salted/dried fish minces is just one of a number of possible methods for preparing protein concentrates from waste fish. A number of approaches have been outlined in this paper and each has advan-

tages and disadvantages. The choice of a method for use in any one situation will depend on the local conditions in the country concerned. Salted/dried fish minces may be produced at a low cost by using unsophisticated processes requiring a low capital input. Unlike FPC type B production, such a process is therefore well suited to a situation where there is only an intermittent or seasonal supply of raw material.

More work is still required. The problem of controlling rancidity when using fatty fish has to be overcome and the possible health risk from incorporating fish guts into products for human food must be evaluated. The method as it stands is most suitable for making products from the flesh of low/medium fat fish; the next stage in the development of the process is to undertake pilot-scale production and large-scale acceptability trials.

Although a number of problems remain, salted/dried fish concentrates would seem to have a great potential as a means of utilizing waste fish for human food and their development will be continued.

Finally, frequent reference has been made to unpublished work carried out by TPI staff members. This work will be published in due course but the authors invite delegates who would like further details of this unpublished work to contact them either personally during the Symposium or by writing to the Tropical Products Institute in London.

REFERENCES

- Allsopp, W.H.L., The utilization of by-catch in shrimp fisheries. *In* Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 287-90
1977
- Amano, K., The influence of fermentation on the nutritive value of fish with special reference to fermented fish products of south-east Asia. *In* Fish in nutrition, edited by E. Heen and R. Kreuzer. London, Fishing News (Books) Ltd., pp. 180-97
1962
- Anderson, M.L. and J.M. Mendelson, A rapid salt curing technique. *J.Food Sci.*, 37:627
1972
- Bligh, G., A note on salt minced fish. *In* Processings of the Conference on the handling, processing and marketing of tropical fish, London, 1976. Tropical Products Institute, pp. 291-2
1977
- Chipault, J.R., G.R. Mizuno and W.O. Lundberg, The antioxidant properties of species in foods. *Food Technol. Aust.*, 10:209
1956
- DAY C., FAO wants more fish used in food aid. *Fish.New Int.* 16(8):74-6
1977
- Del Valle, F.R., A quick salting process for fish. *In* Fishery products, edited by R. Kreuzer. West Byfleet, Surrey, Fishing News (Books) Ltd.
1974
- Del Valle, F.R. and J.T.R. Nickerson, A quick salting process for fish. 1. Evolution of the process. *Food Technol. Aust.*, 22:1036
1968
- Del Valle, F.R. *et al.*, Bacteria counts and rancidity estimates of stored quick-salted fish cakes. *J.Food Sci.*, 38: 580-2
1973
- Duerr, J.D. and W.J. Dyer, Proteins in fish muscle. 4. Denaturation by salt. *J.Fish Res. Board Can.*, 8(5):325-31
1952

- Faubeau, A., Le nuoc-mam: uno providence pour les pays en voie de development. *In Proceedings of the Conference on the handling, processing and marketing of tropical fish*, London, Tropical Products Institute, 1977 pp. 283-6
- FAO, Report of the FAO/NORAD Round Table discussion on expanding the utilization of marine fishery resources for human consumption. Organized in collaboration with the Svany Foundation and held in Svany, Norway, 25 August-4 September 1975. *FAO Fish.Rep.*, (175):47 p. Issued also in French and Spanish
- Finch, R., Whatever happened to fish protein concentrate? *Food Technol.Aust.*, 1975 May issue:44-53
- Fougere, H., The water transfer in codfish muscle immersed in sodium chloride solutions. *J.Fish Res. Board Can.*, 1952 9(8):388-92
- Halliday, D. and J.G. Disney, Fish protein concentrate; a review. *Rep.Trop.Prod.Inst.*, (G58) 18 p. 1972
- James, D.G. and W. Krone, Developments in fish utilization. *In Proceedings of the Conference on the handling, processing and marketing of tropical fish*. London, Tropical Products Institute, pp. 467-73
- Ke. P.J., D.M. Nash and R.G. Ackman, Mackerel skin lipids as a highly unsaturated fat model system for the determination of antioxidative potency of TBHQ and other antioxidant compounds (in preparation)
- King, F.J., J.H. Carver and R. Prewitt, Machines for recovery of fish flesh from bones. *In Oakbrook Seminar on the mechanical recovery and utilization of fish flesh*, edited by R. Martin. Washington D.C., National Fisheries Institute, pp. 213-22
- Lovern, J., General outlook for edible fish protein concentrates. *World Protein Resource*. Washington, D.C., American Chemical Society 1965
- Meinke, W.W. The potential of the by-catch from shrimp trawlers. *In Fishery products*, edited by R. Kreuzer. 1974 West Byfleet, Surrey, Fishing News (Books) Ltd., pp. 233-1
- Mossel, D.A.A., Water and micro organisms in foods—a synthesis. *In Water relations in foods*, edited by R.B. Duckworth. London, Academic Press, pp. 347-60
- Poulter, R.G. and J.G. Disney, Development of novel products from tropical fish species. Paper presented to the 1977 Second Annual Tropical and Subtropical Fisheries Technology Conference of the Americas, Biloxi, U.S.A.
- Spinelli, J. *et al.*, Expanded uses for fish protein from underutilized species. *Food Technol.Aust.*, 1977 May issue
- Steinberg, M.A., J. Spinelli and D. Miyauchi, Minced fish as an ingredient in food combinations. *In Proceedings of the Conference on the handling, processing and marketing of tropical fish*. London, Tropical Products Institute, pp. 245-8
- Sumner, J., A feasibility study for fish silage production in the Indo-Pacific Fisheries Council region. Paper presented at the second meeting IPFC working party on fish technology and marketing, Colombo, Sri Lanka, 25-28 October
- Tagle, M.A., S. Valand and D.G. James, Acceptability testing of FPC type B in selected developing areas. *In Proceedings of the Conference on the handling, processing and marketing of tropical fish*, London, Tropical Products Institute, pp. 261-8

- Van Veen, A.G., Fermented and dried seafood products in Southeast Asia. *In* Fish as food, edited by G. Borgstrom. London, Academic Press, Vol. 3:227-47
1965
- Watts, B.M., Meat products. *In* Lipids and their oxidation, edited by H.W. Schultz, E.A. Day and R.O. Sinnhuber. Connecticut, AVI, pp. 202-14
1962
- Wojtowicz, M.B. *et al.*, A technique for salting lean minced fish. *Tech.Rep.Fish Mar.Serv.Can.*, 1977:15 p
1977

PROCESSING OF NON-COMMERCIAL AND LOW-COST FISH IN MALAYSIA

by

Q.L. Yeoh and Z. Merican
MARDI, Serdang
Selangor, Malaysia

Abstract

Traditional methods of processing surplus and low-cost fish in Malaysia include drying, smoking and fermentation. These traditionally processed products include dry and/or salted sea foods (fish including *Stolephorus* sp., prawns, shrimps, cuttlefish, squids, shellfish, jellyfish), smoked fish, 'pickled' shrimps (cencalok), fermented shrimp paste (belacan), concentrated prawn extract (heko), fermented fish sauce, fish balls and fish cakes.

Conversion of the prawn by-catch into fish meal is faced with the problem of high capital outlay for fishmeal plants, transportation and handling of the by-products and the quality of the by-catch and the finished meal.

A simpler and more economical method of processing the by-catch into silage for animal feed has been successfully demonstrated. This method makes use of a lactic acid fermentation system and is recommended for use in fishing villages.

INTRODUCTION

In Malaysia, traditional methods of preserving non-commercial fish include drying, smoking and fermentation. With the introduction of trawling, the amount of non-commercial fish has increased tremendously. It has been estimated that about 60 percent of the fish caught falls into this category (Kamari *et al.*, 1977).

It is, therefore, essential that the use of the by-catch be maximized to counter-balance the increasing cost of fishing operations. Some of this fish is, at present, preserved by drying or fermentation but, usually, only on a cottage industry scale. The fermentation process normally involves the use of high proportions of salt and the market for these types of products is rather limited.

A large proportion of this fish is converted to fish meal but this is possible only in areas where the non-commercial fish is concentrated in one area, as a large and regular supply of the fish is essential. The setting-up of a fishmeal plant also involves large capital outlay. Work has, therefore, been initiated to study the possibilities of converting this by-catch to fish silage for animal feed.

TRADITIONAL PRODUCTS

Traditional products processed by fermentation include belachan, budu and cencalok, while those preserved by salting and/or drying are salted and/or dried sea products (which include fish, squids, sepia, jellyfish, shellfish, prawns). Heko (a concentrated prawn extract), fish balls and fish cakes are primitively processed, while smoked fish has only been recently introduced for the Japanese market.

Belachan

Belachan or shrimp paste is a traditional preparation of salted and fermented minced shrimp of a tiny *Acetes* species. It is a thick, salty paste having a strong pungent odour of shrimp and a colour ranging from greyish pink to greyish purple. It is well established as one of the main condiments in Malaysian cuisine and is normally added as a flavouring ingredient in most spicy foods, especially seafood. However, the acceptance of

shrimp pastes, like the fish sauces, is an acquired taste and requires cultivation. The amount consumed varies with the individual but it is well accepted by all, irrespective of their social and economic status. Because of its high salt content, only small quantities can be consumed at each meal but, in the rural areas, this is often one of the most important sources of protein. It is also popular in the neighbouring countries and is known by different names: kappi in Thailand, ngapi ni Burma, trassi in Indonesia.

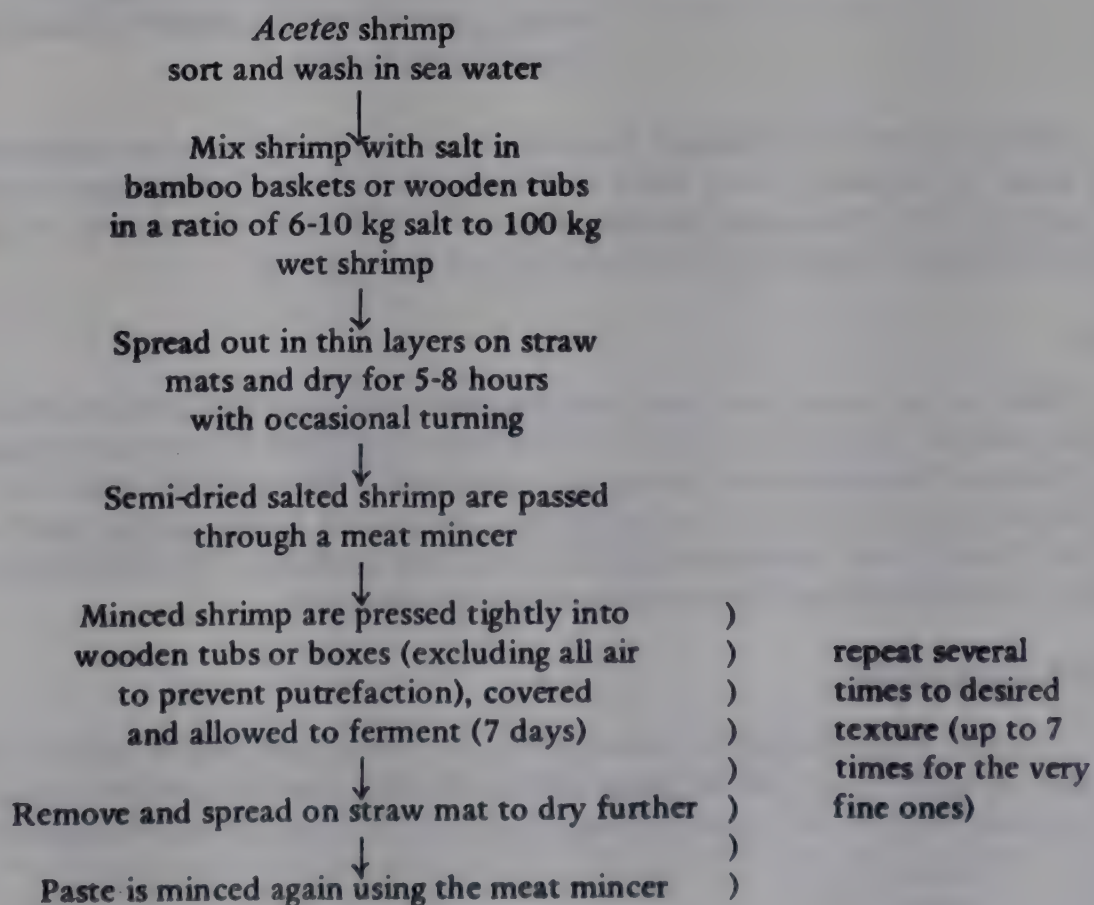
Methods of preparation

The production of belachan is still a thriving cottage industry along the coast of several states, especially Penang. Production is still largely a family concern. The utensils and equipment required include a meat mincer or wooden pestle for pounding, wooden tubs with covers, straw mats, bamboo trays, wooden stands and a drying area which is usually on the beach.

The main raw material is the *Acetes* shrimp. Although the genus *Acetes* (Milne-Edwards) is a minor crustacean group represented by a few species, it supports a subsistence fishery of some considerable importance in Malaysia. There are four important species which appear in very large swarms in the brackish shallow inshore coastal waters, with a salinity of 0.3 percent or less during certain seasons of the year (Pathansali, 1966). The nets used to catch these tiny shrimp include push and beach nets, small purse seines and stake traps. A greater part of the catch is processed into belachan. In Penang and the northwest coast of Peninsular Malaysia where most of the belachan factories are situated, the species normally found are *A. japonicus* (Kishinouye) and *A. sibogae* (Haugen). *A. erythraeus* (Nobili) is found exclusively on the east coast while *A. indicus* (Milne-Edwards) is found in the southern seas of Peninsular Malaysia.

The shrimp is heavily salted; salt forms the only other main ingredient. Some processors add artificial colouring or red rice to make their products more attractive.

It is suspected that the tissues undergo enzymic breakdown during the fermentation since fermentable carbohydrate is very low in the shrimp. Bacterial action, which may or may not assist in proteolysis, is assumed to play an important role in flavour development. The method of preparation is shown in Fig. 1.



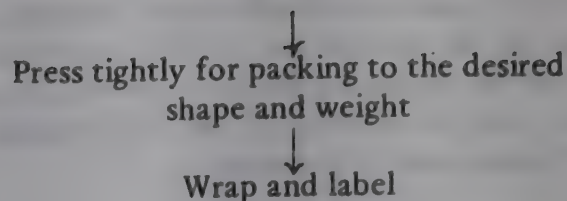


Figure 1 Flow chart of belachan production

During fermentation, the tiny gritty shrimp is transformed into a fine meaty paste which has a characteristic strong pungent fishy odour. The following table summarizes the chemical composition of belachan. Since there is no control exercised over its process, the range and inconsistency between samples is wide.

Table 1
Composition of belachan^{a/}

pH	7.2–7.8
% Ash (including salt)	20–27.6
% Moisture	27–40
% Total sugar	0.5
% Salt (NaCl)	13–25.3
% Fat	1.4–2.6
% Protein	28.7–40
% Calcium	2–3.4
% Iron (Fe)	0.02
% Thiamine	Trace
% Riboflavin	0.001
% Niacin	0.004

a/ Source: Chong, Nutrition Division, IMR, Kuala Lumpur and Chia, MARDI, Serdang (unpublished data)

There are very few licensed factories but many small backyard manufacturers in the fishing villages and rural areas. An estimate, in the State of Penang, puts the number of these 'factories' at 30, scattered throughout the state. In 1971, Peninsular Malaysia exported 4 074 tonnes of belachan valued at U.S.\$ 469 079^{1/}. Most of it went to Thailand, Singapore, the Netherlands and Hong Kong.

Budu

Budu or fish sauce is a clear liquid ranging from amber to dark brown in colour which is rich in salt and soluble nitrogen compounds. Budu is known only to Malays of the eastern states of Peninsular Malaysia comprising Kelantan, Trengganu and Pahang and processing is limited to this region. It is used in almost every home as a condiment in place of soy sauce. It can be used to add a salty taste to spicy dishes or used as a dip with hot chillies. Outside these three states the sauce is almost unknown. The fermentation is usually carried out at certain months of the year when there is an abundance of anchovies.

Method of preparation

The only utensils required are a cylindrical cement tank with a cover for fermentation, a large cauldron, a fireplace to boil the fermented sauce, filling buckets, wooden paddles, spoons and a manual corking device. Capital outlay is small and ranges perhaps from M.\$ 200-1 000,^{2/} depending on the scale of production.

1/ Source: Statistics Dept.

2/ M.\$ 1 = U.S.\$ 0.42

The basic ingredient is anchovies, locally known as ikan bilis (*Stolephorus* sp.) which come from the surrounding fishing villages. Five types are recognized and these are named bilis tembaga, bilis jalor, bilis mayam, bilis puteh and bilis sungai, according to their morphology and locality.

Other ingredients include salt, lime or tamarind and palm sugar. The fish are sorted, washed and mixed with salt in the ratio of 3:1 and allowed to ferment anaerobically in closed containers. Some manufacturers add tamarind juice or lime and palm sugars to the above mixture before fermentation. The substrate is left for several months (6 months-2 years) for proteolysis to take place. When the product is mature, as indicated by a film of oil on top of the liquid mash, it is harvested, boiled in an open cauldron, cooled, filtered and bottled. Fig. 2 is the flow chart showing the method of preparation. Since these products are not properly pasteurized, microbiological post-process contamination can cause spoilage of the product and the shelf-life is shortened.

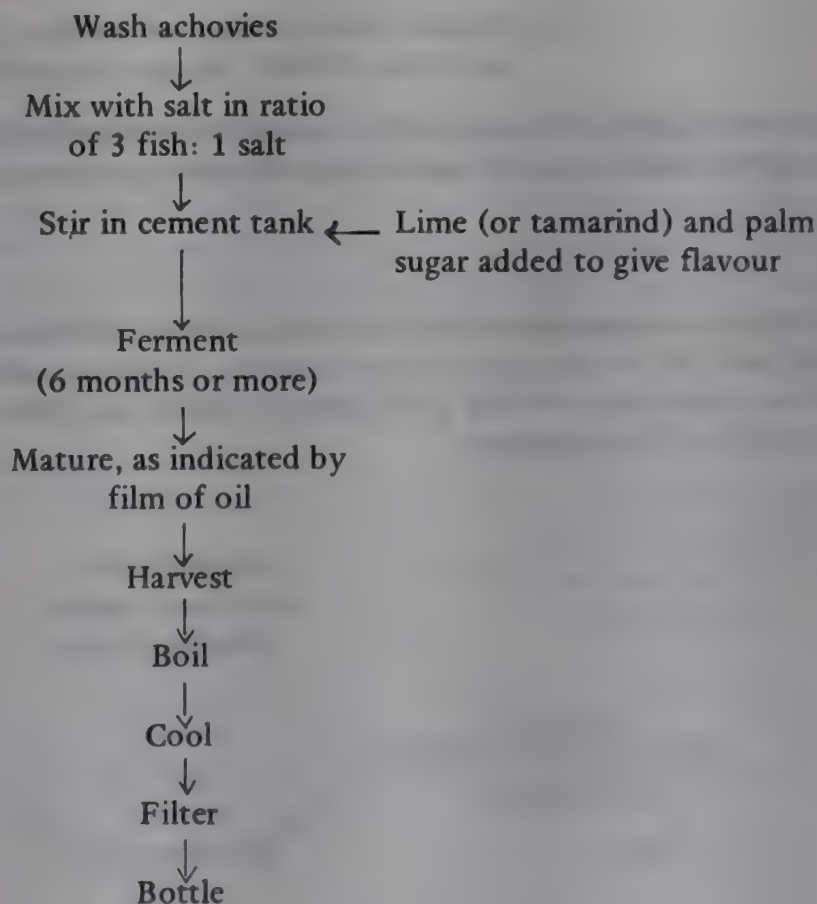


Figure 2 Flow chart for budu production

The fermentation pathway is still being investigated by several workers. It is assumed that when no fermentable carbohydrate is added to the fish salt mixture, the fermentation is affected by the enzymes of the fish. However, the microflora may be necessary for the development of aroma and flavour. When palm sugar is added (as done by some processors), the fermentation could be affected by both fish and microbial enzymes. The composition of budu is shown in Table 2.

Table 2

Composition of budu^{a/}

pH	5.4–6.2
% Ash (including salt)	18.3–20.9
% Acidity (as acetic acid)	0.4–0.9
% Moisture	54.8–76.0
% Total sugar	0–7.42
% Salt (NaCl)	21.7–28.15
% Fat	0.2–1.0
% Protein	5.8–11.5
% Calcium	10.2
% Iron (Fe)	0.4
% Vitamin B ₁	0.004
% Vitamin B ₂	0.010
% Niacin	0.20

a/ Source: Chong, Nutrition Division, IMR, Kuala Lumpur and Chia, MARDI, Serdang (unpublished data)

Due to the mobility and migration of communities from one location to another, fish sauce is being introduced to the other localities as well and is gradually gaining acceptance by the other communities.

Cencalok

Cencalok (pronounced chenchalok) or pickled *Acetes* shrimp, somewhat similar to bagoong from the Philippines, is made only in the southern Malaysian state of Malacca and is popular only with people in that locality. The product is a suspension of tiny pink shrimp in sauce and tastes salty with a very strong shrimp smell. Fig. 3 shows a flow chart of the operation.

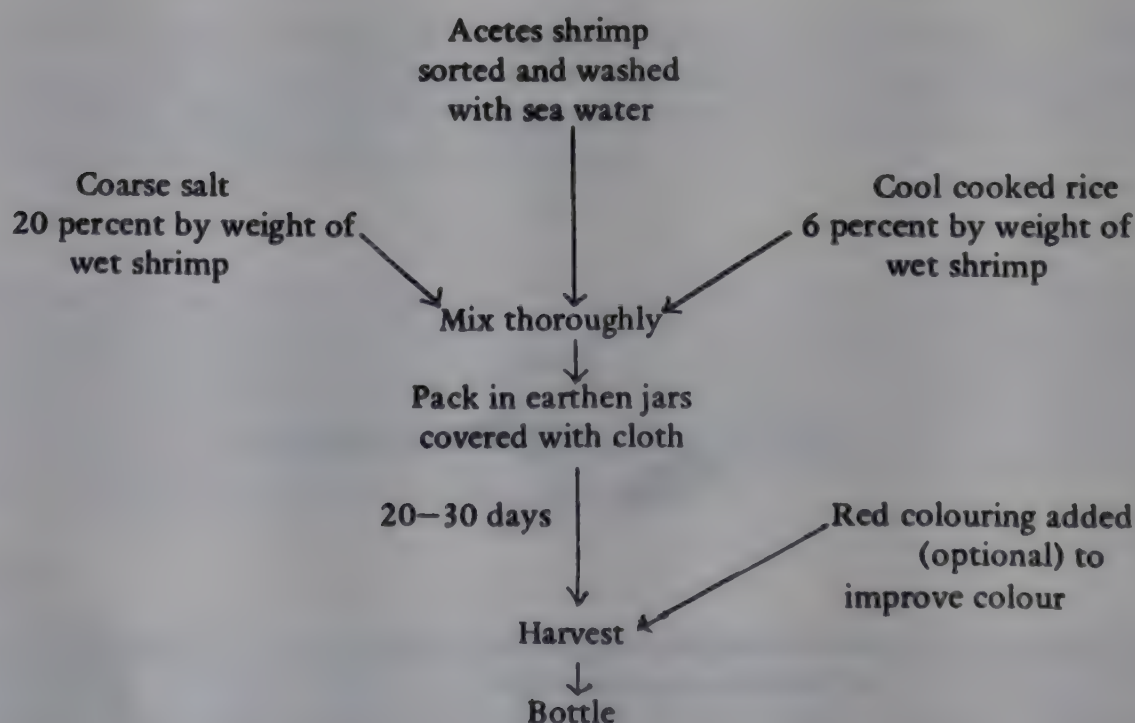


Figure 3 Flow chart for cencalok production

During the vigorous fermentation stage, the brine overflows and attracts flies, often resulting in maggot infestation. Thus, the hygiene and sanitation aspect of this and other fermented fish industries leaves much to be desired.

Fish balls and fish cakes

The product is made on a small scale and is a flourishing backyard industry among Malaysians of Chinese origin. The fish normally used are either the wolf herring (*Chirocentrus dorab*), locally known as parang, or the tenggiri, i.e., Spanish mackerel (*Scomberomorus guttatus* and *S. commersoni*). A summary of the methods generally used is shown in Fig. 4.

The ingredients added by commercial enterprises are to reduce cost. Sodium borate, although not allowed by the Malaysian Food and Drug laws, is detected in some samples and its function is believed to increase the rubbery texture of the product. Polyphosphate is added to increase the water retention properties of the fish while monosodium glutamate adds flavour and starch increases the bulk. It has been claimed that, by using fish meat alone, the rubbery texture can be attained by 'bouncing' the kneaded dough thoroughly.

Though the two fish named above are medium-priced fish, it is hoped that non-commercial fish with the same properties can be utilized for fish ball or fish cake production.

Dried and/or salted fish

The number and types of dried/salted seafoods range from jellyfish to excess commercial fish. The most popular dried/salted fish is bilis (anchovies). Anchovies are boiled in 30 percent brine on board boats immediately after catching. They are then brought ashore and sun-dried on mats on raised platforms or directly on the ground. Jellyfish are stacked in alternate layers of salt and fish for a few days, then soaked in a solution of brine and metabisulphate to decolourize the product. The thin layers are then dried slowly in stacks under a shade. Sidaway and Balasingam (1971) reported the methods of drying fish which are commonly practised in Malaysia.

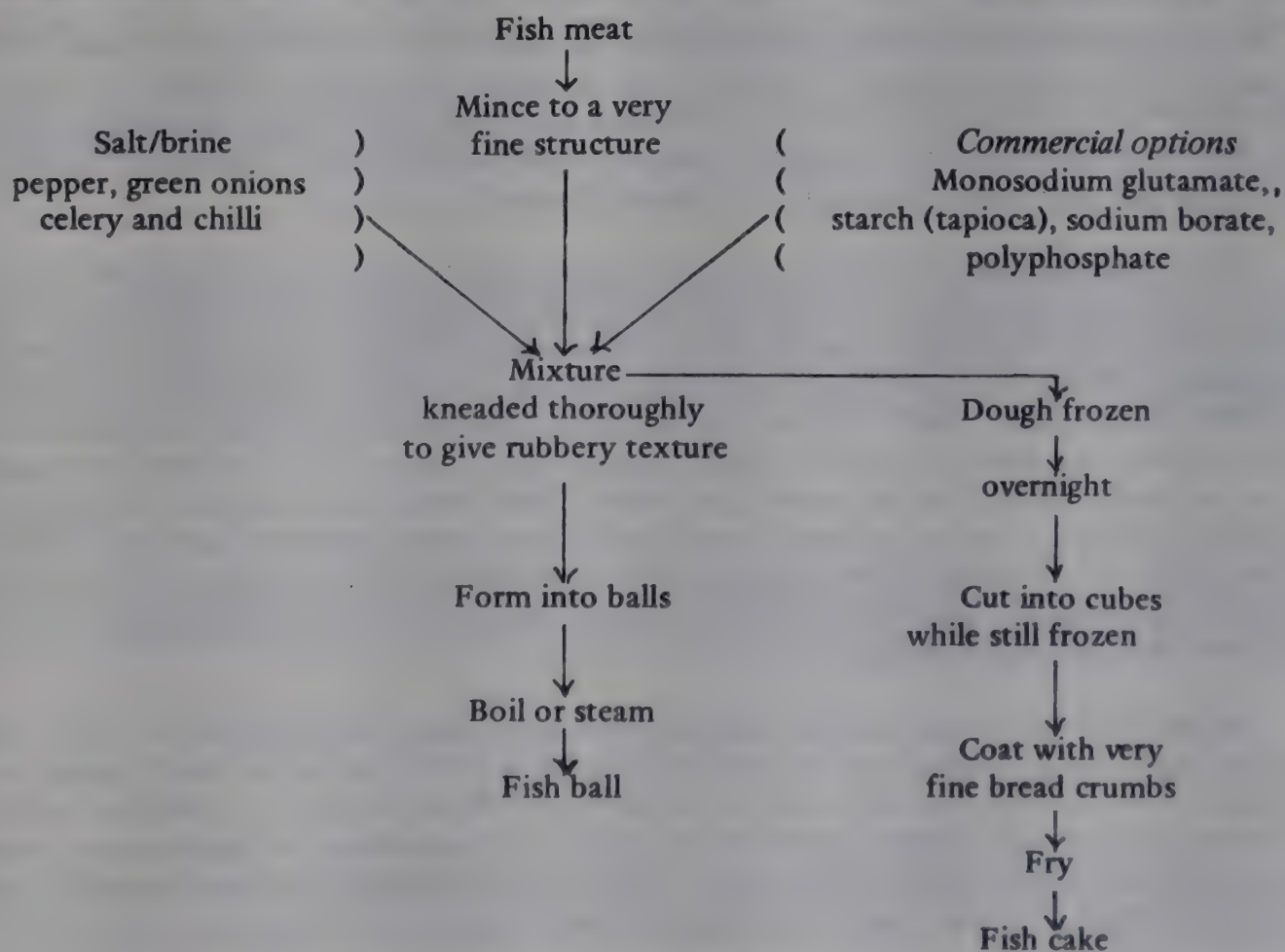


Figure 4 Flow chart for fish ball or fish cake production

Heko

Heko is a concentrate of prawn extract made in the northern state of Penang by Malaysians of Chinese origin. Extract of whole prawns and sometimes fish is concentrated by boiling to a very thick viscous consistency. Other ingredients such as sugar and flour may be added to aid thickening. This concentrate is used as condiments in fish dishes. The product is described in more detail by Sidaway and Balasingam (1971).

Kerupuk

Kerupuk (fish/prawn cracker) is a popular snack among Malaysians. It is made from deboned fish or prawns, tapioca or sago flour and salt thorough kneaded into a dough. The dough is steamed, cut and sun-dried (Sidaway and Balasingam, 1971).

Fish meal and fish manure

Fish meal and fish manure are the only outlet for trash fish at the present time. Because of seasonal fluctuations, long distances from fishing ports (thus affecting quality of the fish) and limited capacity, a high proportion of trash is wasted. Since this subject is dealt with in another paper at this meeting (Idrus *et al.*, 1978), an alternative, new non-traditional method of processing by-catch is presented.

Fish silage

Although the principle of ensilage has been practised in Europe for many decades, there has been little interest in the application of this technique in Malaysia until recently. Current areas of research include the ensiling of pineapple waste, cattle droppings, chicken manure and trash fish for conversion to animal feed. Our research has concentrated on the utilization of trash fish only, though the use of pineapple waste as an alternative carbohydrate source to cassava appears to have potential.

It is envisaged that the ensiling process will be initiated on the trawlers and continued at the fishing villages. The level of technology employed must, therefore, be simple, inexpensive and safe. For these reasons, we have concentrated on a fermentation method which does not involve the dangers of handling strong acids. Furthermore, the cost is less as it is not necessary to use acid-resistant containers, to purchase expensive organic acids, or to neutralize the silage before feeding to the animals (Disney *et al.*, 1977).

The underlying principle of this method of preserving the proteinaceous material is the rapid lowering of the pH due to the production of lactic acid by the lactic acid bacteria. The resultant pH is unsuitable for the growth and survival of pathogens and putrefactive bacteria, thus preservation is achieved (von Hofsten and Wirahadikusumah, 1971). It has also been found that addition of suitable carbohydrates will improve the fermentation (Nilsson and Rydin, 1963). A source of amylolytic enzymes to hydrolyze the starch to fermentable sugars is also essential. For our work, we have tried to make use of cheap, locally available raw materials only; the method is as follows. Whole fish are washed and minced finely using a meat chopper. This is then mixed with a predetermined quantity of ground cassava flour. A local starter, *ragi* which contains strains of amylolytic fungi (Stanton and Yeoh, 1977) is then added, together with an inoculum of lactic acid bacteria produced by a sauerkraut-equivalent fermentation. The whole mixture is packed into air-tight containers, kept at room temperature (28°-30°C) for the fermentation process.

We have also found that, by the addition of 3-4 percent salt, the proportion of fish to carbohydrate can be increased significantly. This is important if the process is to be started on board ship as it would reduce the quantity of raw materials that have to be taken out to sea. The salt appears to serve three main functions. It helps to eliminate the non-salt tolerant organisms. Secondly, it helps to lower the water activity of the silage, thus contributing to the shelf-life of the final product. Thirdly, it makes conditions more favourable for the desired lactic acid bacteria which grow well under halophilic conditions.

Table 3 gives a summary of the formulations of some of our successful trials. Details of our trials have been reported earlier (Yeoh *et al.*, to be published).

Table 3

Silage formulations

Ingredients (%)	Trial numbers			
	I	II	III	IV
Fish	50	60	80	80
Cassava	50	40	20	20
Ragi	5	5	5	5
Starter culture	2	2	2	2
Salt	0	0	4	5

The finished product is a semi-solid mixture which can be fed direct to animals or dehydrated before feeding. After dehydration, analysis of the 4 percent salt-assisted fermentations showed that it contained 6.4 percent moisture, 33.9 percent crude protein and 7.6 percent lactic acid with a pH of 4.4. This dehydrated silage was then used for preliminary feeding trials on rats. The results show that, over a three-week period, the weight gain showed little difference from the control group and the silage appeared to have no toxic effect on the animals (Yeoh *et al.*, to be published). However, feeding trial experiments carried out in other countries have shown rather conflicting results. More work has to be carried out with our samples before any conclusion can be drawn.

Thus the data compiled so far seem to indicate that this process has potential for adaptation at cottage industry level for the preservation of non-commercial fish.

CONCLUSION

This paper briefly describes some of the traditional methods used in Malaysia for the utilization of low-cost fish. It also reports a new method for the preservation of fish by the process of ensiling which appears to have potential for the by-catch in this region. The use of all these methods will maximize the utilization of the low-cost and non-commercial fish in Malaysia and contribute significantly to the salvaging of good protein which is at present wasted.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance given by their colleagues and the laboratory staff. The continued interest of our Head of Division and the kind permission of the Director General of MARDI are greatly appreciated.

REFERENCES

- Disney, J.G., I.N. Tatterson and J. Olley, Recent developments in fish silage. *In* Proceedings of the Conference 1977 on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 237-40

- von Hofsten, B. and S. Wirahadikusumah, Preservation of fish and other protein-rich products by lactic acid
1971 fermentation. *In* Waste recovery by micro-organisms, edited by W.R. Stanton. Kuala Lumpur, Malaysia, Dewan Bahasa dan Pustaka, Unesco/ICRO Work Study, pp. 63-72
- Kamari, A., A.Z. Idrus and Z. Merican, The handling and transportation of fish in Malaysia. *In* Proceedings of
1977 the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 115-9
- Nilsson, R. and C. Rydin, Fermentation as a means of preserving organic materials. *Acta Chem.Scand.*, 17:73-9
1963
- Pathansali, D., *Acetes* (Sergestidae) from Malay Peninsula. *Bull.Ike Natl.Mus.Singapore*, 33. Part 8 pp. 59-63
1966
- Sidaway, E.P. and M. Balasingam, Fish processing industry in West Malaysia. Kuala Lumpur, Division of Food
1971 Technology, Ministry of Agriculture and Fisheries
- Stanton, W.R. and Q.L. Yeoh, Low salt fermentation method for conserving trash fish waste under South-East
1977 Asian conditions. *In* Proceedings of the Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 277-82
- Yeoh, Q.L., W.R. Stanton and T.K. Murkerjee, Production of fish silage for animal feed. *In* Proceedings of the
Symposium on feedingstuffs for livestock. Kuala Kumpur, Malaysia (to be published)

THE PRODUCTION OF FISH BALLS AND FISH CAKES IN SABAH AND THE POSSIBLE USE OF TRAWLER BY-CATCH FOR SUCH PRODUCTS

by

P.J.I. Snell
Department of Fisheries
Kota Kinabalu
Sabah, Malaysia^{1/}

Abstract

The existing production of fish balls and fish cakes in Sabah is described and the constraints on further development of the industry are detailed. The results of taste panel trials on seven common species from the prawn trawler by-catch showed that three species, *Leiognathus splendens*, *Nemipterus japonicus* and *Saurida tumbil* were particularly suitable for these types of products. The economics of preparing suitable fish minces from such species were studied.

INTRODUCTION

Considering the large resource of non-utilized fish caught by prawn trawlers and the possible use of meat separators to prepare minced fish flesh from such materials, it was decided to investigate the suitability of such minced fish for the preparation of consumable products. Apart from western-style products, such as fish fingers, local-style products with a rubbery texture, such as Chinese fish balls, were thought suitable for investigation. The review of their production is based on the observation of a fish ball plant in Kota Kinabalu, of the most modern plant in Singapore and on statements by the largest producer of fish balls in Sandakan.

FISH BALL PRODUCTS

Commercial production of these products in Sabah is thought to be restricted to fish balls and fish cakes. The former are widely used in soups while the latter are sliced and are usually either added to soups or fried with noodles. Fish balls are normally boiled for a few minutes before sale; fish cakes are fried to impart extra flavour and give an attractive yellowish coating to the outside.

In Singapore, a variety of other products are produced commercially, such as bean curd stuffed with a similarly textured fish meat filling but fish balls are the most widely produced product of this type.

Production of fish balls and fish cakes

The raw material

Opinions differ regarding the best raw material for fish balls. In Kota Kinabalu, the local plant manager claims he only uses ian sulit (*Caesio* spp.), which are widely regarded as the best fish. However, in Sandakan a trawler fleet owner is reported to use a variety of fish including *Trichiurus* spp., *Sciaenidae*, *Saurida* spp., and *Muraenesox* spp. In Singapore, imported fish such as grenadier, blue whiting and slime heads^{2/} are used; clupeids are regarded as a good fish for fish balls.

1/ The paper was written during the author's assignment with the Department under the U.K. Voluntary Service Overseas scheme

2/ Common English names are used since identification was not possible

Since the frying of fish cakes masks the fish flavour, a variety of fish species may be used. It was stated in the plant at Kota Kinabalu that *Nemipterus* spp. are used most frequently but sharks, *Saurida* spp., *Rastrelliger* spp. and *Lutjanus* spp. are also used. However, during a visit to the plant it was noted that most trawl species were being used including Sciaenidae, *Leiognathus* spp., flatfish and *Pomadasys* spp.

Preparation

The fish are beheaded and gutted manually. To facilitate this operation, one manager used a simple guillotine designed to cut paper (Fig. 1). The manager in Singapore skinned and filleted the larger imported fish apparatus recently to improve the yield of meat.



Figure 1 — The use of a simple handguillotine to prepare fish.

When these products are produced on a small scale, as in the home, the fish are filleted and the flesh is separated from the skin and frame using a spoon (Fig. 2). However, in larger plants mechanical separators are used of which there are two types. The older type (Fig. 3) has a flat perforated disc through which the fish flesh is pressed by a rubber-footed ram, but the more modern perforated drum separator (Fig. 4) is now being introduced. The mincing operation is normally carried out by passing the separated flesh through two modified simple hand mincers which have been connected by a chain drive to electric motors (Fig. 5). Mixing is carried out using a simple mixer with an electrically driven anchor-type impeller (Fig. 6). During mixing, salt, monosodium glutamate and other flavourings are added. Chemicals such as sodium bicarbonate may also be added to improve the texture and water is added until the operator assesses that the optimum texture has been reached. It appears that a wide range of additives are used by some processors in addition to the basic ingredients listed above but no accurate details of these are available.

Traditionally, fish balls are shaped by hand using a spoon and even in larger plants this method is still used if a small number of non-standard size fish balls are to be made. However, forming machines, which extrude cylinders of the mix and cut them off in regular sizes, are now widely used. The older type maintained the fish ball mix under pressure using a screw press and formed six fish balls simultaneously. However, the most

modern machines operate using a fast, shaped impeller which pushes the fish ball mix at a cylinder through one set of cutter plates. Such machines can produce up to 300 fish balls per minute; the fish balls are allowed to drop into a bowl of water or extremely weak brine solution in which they are allowed to set. They are then briefly boiled before sale.

For fish cakes the mix is placed in a wooden or metal frame with sides about 6 cm high (Fig. 7). When the mix has set, it is sliced into portions of about 15 x 6 x 1 cm which are deep-fried for a short time in large curved-bottomed pans (Fig. 8) before sale.



Figure 2 — The manual separation of flesh from fillets using a spoon

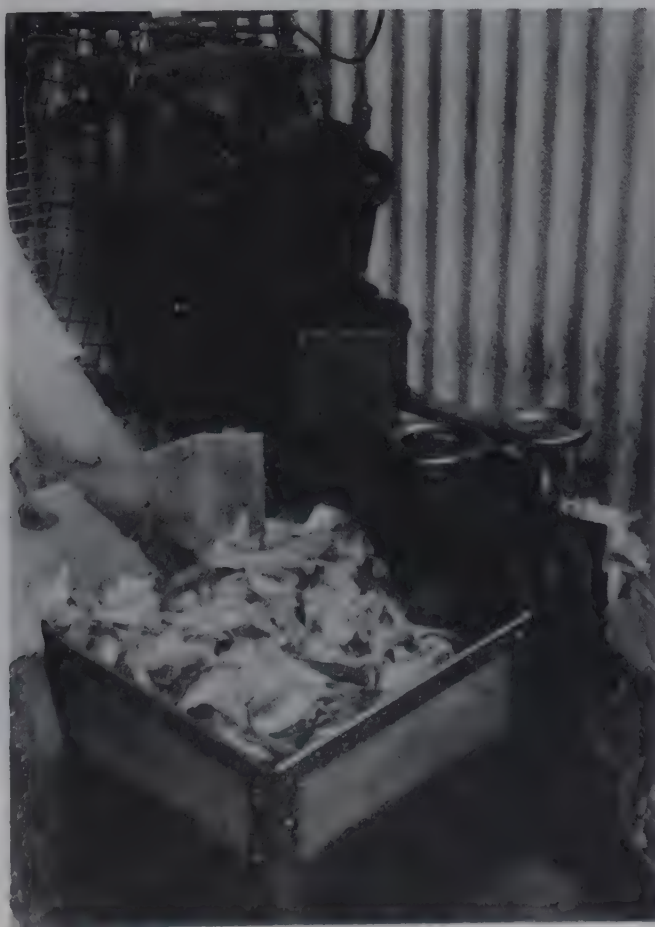


Figure 3 — The disc-type meat separator. Separated meat is pushed through the perforations into a collection bucket by the ram shown in mid centre of the picture

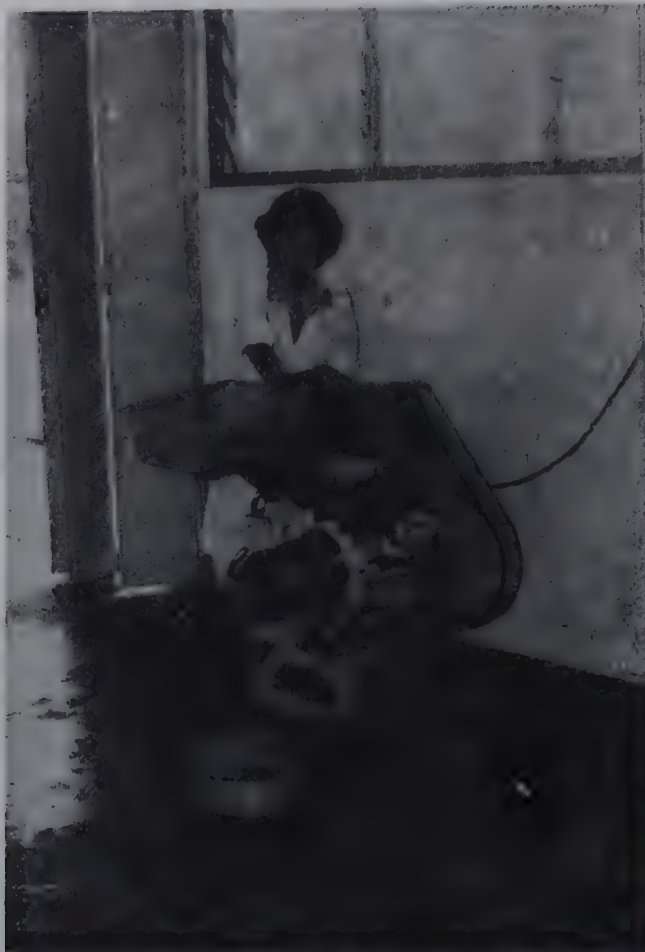


Figure 4 — The drum-type meat separator as used at the fisheries research centre



Figure 5 — One of the simplest types of mincers used in fish ball production

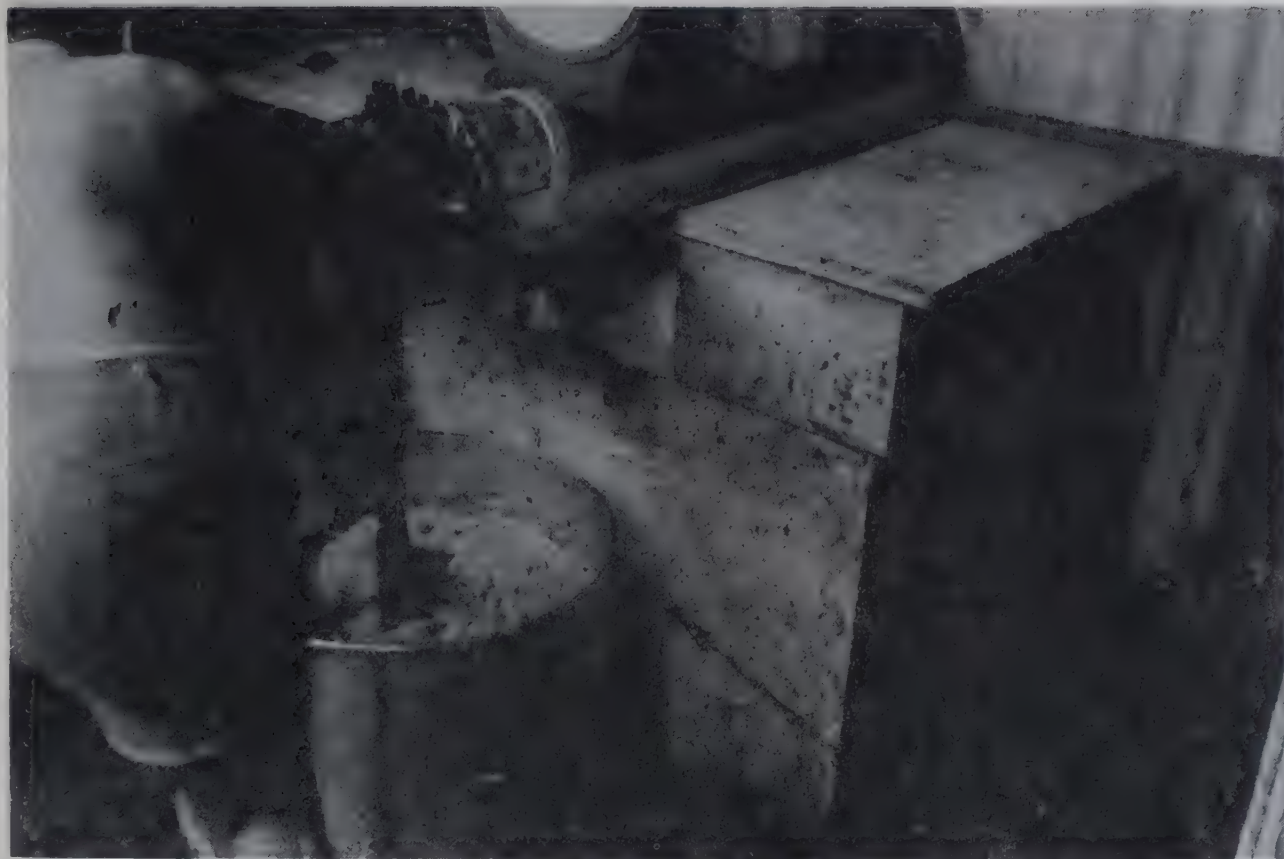


Figure 6 — Adding ingredients to the fish ball mix in a simple mixing machine

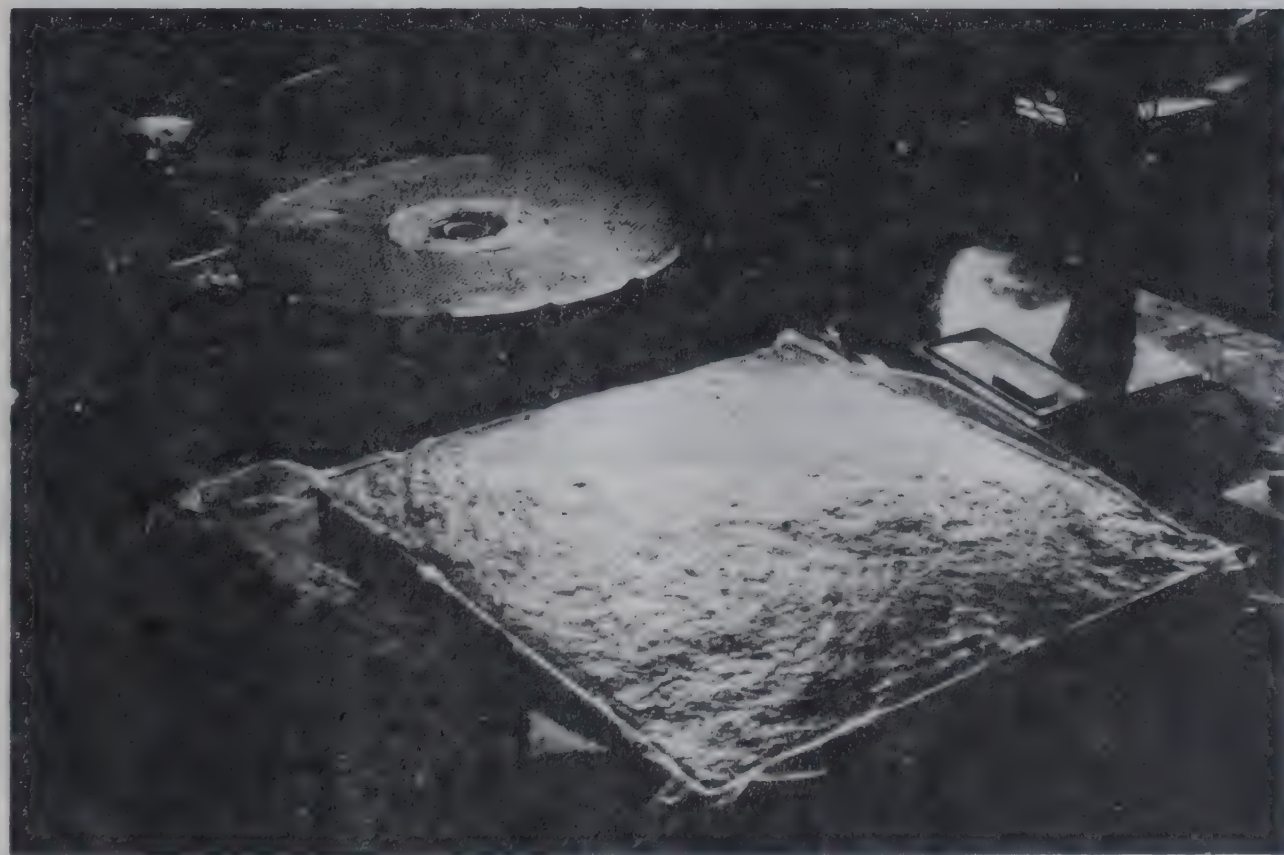


Figure 7 — The fish cake mix being left to set in a mould. The perforated disc from the meat separator is shown in the background



Figure 8 — Large curved-bottom pans used to fry fish cakes before sale

Fish balls and fish cakes in Sabah

Almost all the fish balls sold in Kota Kinabalu are produced by one man who has built a small processing plant under his house; he obtains fish either from the fishermen or the wholesalers. All operations, apart from preparation and gutting of the fish, are carried out mechanically although the machinery used is relatively primitive compared to the equipment used in Singapore. In Kota Kinabalu and nearby small villages, he is able to sell up to 60 kg each of fish balls and fish cakes per day but, due to erratic supplies of raw materials, was unable to estimate the average sales. Fish balls are sold at M.\$ 3.50 per kati (U.S.\$ 1.50 per 0.6 kg) and fish cakes, which were sold by piece rather than by weight, were sold at approximately M.\$ 3 per kati (U.S.\$ 1.30 per 0.6 kg). Some fishmongers are believed to prepare fish balls in small quantities and many people prepare them in their own homes.

In Sankadan, a trawler fleet owner started production of fish balls in order to use some of the large quantities of unmarketable fish which were caught by his boats. He reports that all operations except mixing are carried out manually and that he sells an average of 250 1-lb (0.45-kg) packs per day at a wholesale price of M.\$ 1 (U.S.\$ 0.42) per pack. The packs are sold by stall holders in the market for M.\$ 1.30 (U.S.\$ 0.55) per pack. More packs could be produced if there was a market for them.

PROCESSING TRIALS

Processing trials were conducted to determine whether acceptable fish balls could be produced from common unmarketable fish.

Methods

Trial 1

Seven genera of unmarketable fish which had been shown to be amongst the most common genera in prawn trawler by-catch (Snell, 1978) were selected for study. Since earlier work by Bremner and Snell (1978) had shown that one of the species of fish was not suitable for frozen storage because of formaldehyde production, the fish used were stored in ice until used for the processing and taste panel trials. Fish caught by a departmental trawler during a two-day collection trip were immediately stored in ice. The fish chosen for study were Ariidae, *Leiognathus splendens*, *Nemipterus japonicus*, *Pomadasys argyreus*, *Pomadasys hasta*, *Saurida tumbil*, Sciaenidae and *Trichiurus lepturus* (Fig. 9). The day following, the different species were separated into large and small fish (as listed in Table 2). The weights of twenty fish selected at random from each group were recorded to give an indication of the weight of fish present in each sample (Fig. 10). These fish were then headed, gutted and descaled (where necessary) by hand and the weight of fish before and after this operation was recorded. The fish were then stored in ice overnight.



Figure 9 — The fish species studied for the preparation of fish balls. Top row (l. to r.) Sciaenidae (marketable), Ariidae (unmarketable), *Leiognathus splendens* (unmarketable). Second row (o. to r.) Sciaenidae (unmarketable), *Leiognathus splendens* (unmarketable). Third row *Trichiurus lepturus* (unmarketable). Fourth row (o. to r.) *Saurida tumbil* (unmarketable), *Nemipterus japonicus* (marketable), *Pomadasys hasta* (marketable). Bottom row (l. to r.) *Saurida tumbil* (unmarketable), *Nemipterus japonicus* (unmarketable), *Pomadasys argyreus* (unmarketable)

The following day the meat was separated from the fish, and fish balls were made from each sample. In each case, separation of the meat from the larger sized fish was done manually (Fig. 2) although, since this was very difficult for the very small *Pomadasys argyreus*, a closely related species, *Pomadasys hasta*, was used instead for manual separation. It was not possible to remove flesh from the belly flaps of *P. hasta* and Ariidae by manual separation. Separation of meat from the smaller sized fish (and of *P. argyreus*) was carried out using a mechanical

drum-type separator with drum hole size of 4 mm (Fig. 4). A description of the appearance of the separated flesh was made in each case and the weight of separated flesh from each portion of each sample was recorded. Approximate times for unskilled female labourers to prepare the fish and to separate the flesh manually were noted and the hours required to carry out each operation on 10 kg of fish were calculated.

Immediately after separation, the flesh was passed through a manually operated mincer with 4 mm diameter holes. The minced fish flesh (600 g) was then weighed out and salt (0.7 percent) and monosodium glutamate (0.3 percent) were added. After thorough mixing, the flesh was pummelled and pounded for up to 20 min until a suitably smooth fish ball mix was prepared. During this process, water was added by an assistant, experienced in making home-made fish balls, to produce the optimum consistency and a record was made of the volume of water added. Thirty six fish balls of approximately equal size were prepared from each batch of fish ball mix; they were stored on labelled polythene sheets in a refrigerator overnight to allow gelling to occur. Taste panels were conducted the following day.

Trial 2

During the initial trial, three species of unmarketable fish (*Leiognathus splendens*, *Nemipterus japonicus* and *Saurida tumbil*) were found to produce relatively high quality fish balls. These fish were again obtained (10 kg) on a further one-day sample collection trip and immediately stored in ice. On the following day a sample of *Caesio erythrogaster* was also obtained from the fish market and all four species were beheaded, gutted and descaled (where necessary) and stored in ice until the processing trials two days later. Before preparation, the weights of twenty randomly selected fish from each sample were recorded (Fig. 11).

Two days later each sample was passed through the drum-type meat separator (Fig. 4) and the flesh was then passed twice through a manually operated mincer with 4 mm diameter outlet holes; 3 kg of flesh from each sample of fish was weighed out and transported to a local fish ball processing plant.

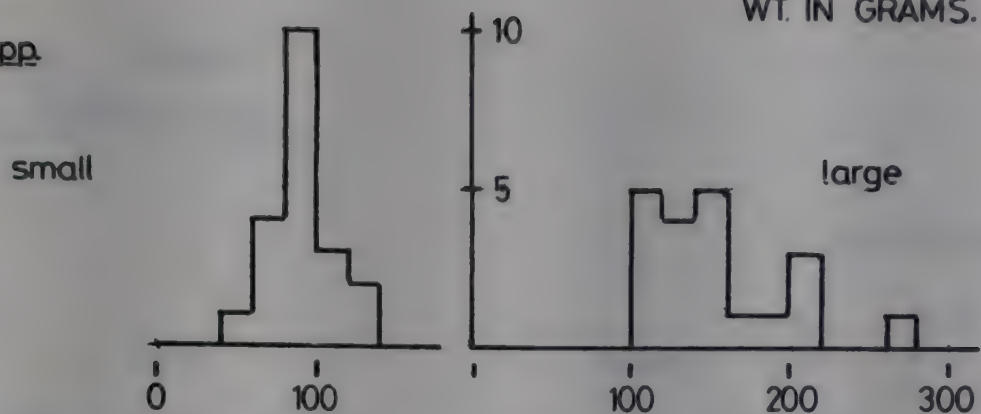
The manager of the plant was given complete freedom to add the necessary quantity of salt, monosodium glutamate and water as determined subjectively by him. The quantity used was recorded. The ingredients were mixed together by squeezing the mixture between his fingers and stirring it strongly around the mixing bowl until it reached a smooth dough-like consistency. The fish balls were prepared manually by forming a cylinder of the mix in the palm of the hand and scooping out fish balls with a small spoon. They were immediately dropped into water and transferred to foil trays covered with aluminum foil two and a half hours later.

Taste panels

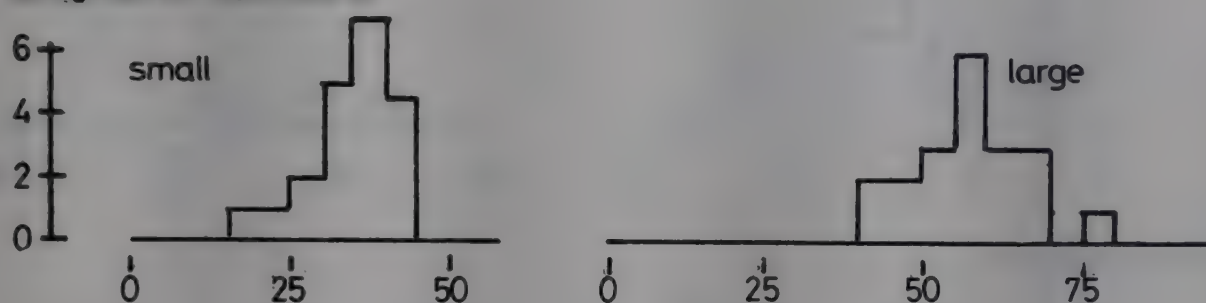
It was not possible to train the panels, as the members (Chinese workers from technical and clerical grades within the Department) were available only temporarily. For similar reasons, different tasters had to be used for the second tasting session. Nine tasters took part in the first panel; ten took part in the second panel. Due to lack of space, only five tasters could be catered for at a time and, therefore, each panel had to be split into two tasting sessions.

SIZE OF BATCH :- 20
WT. IN GRAMS.

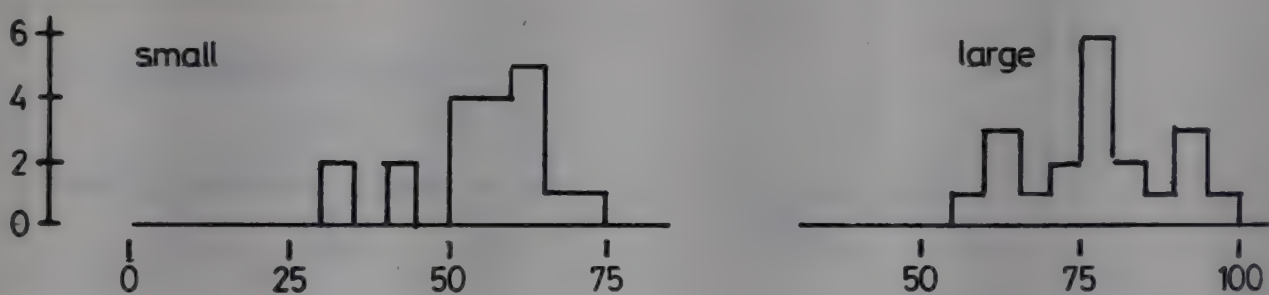
a) Arius spp.



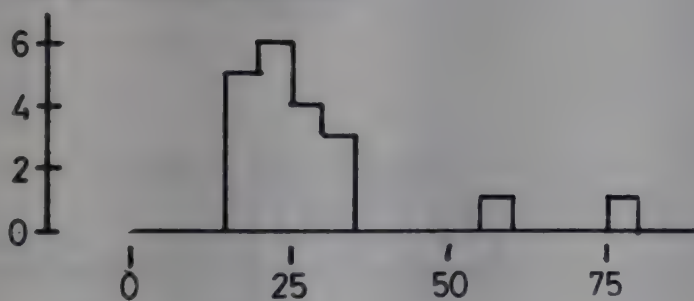
b) Leiognathus splendens



c) Nemipterus japonicus



d) Pomadasys argyreus



e) Pomadasys hasta

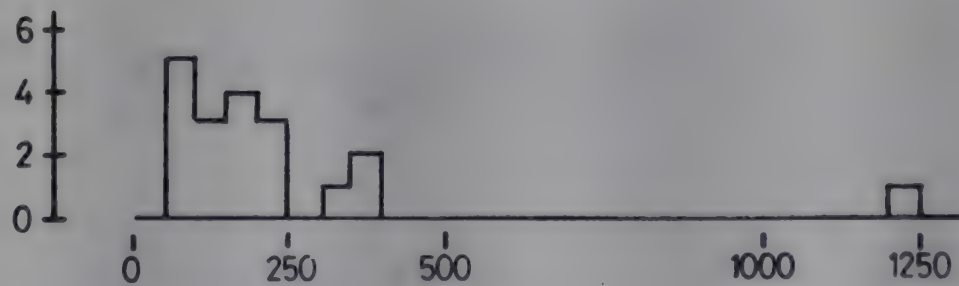
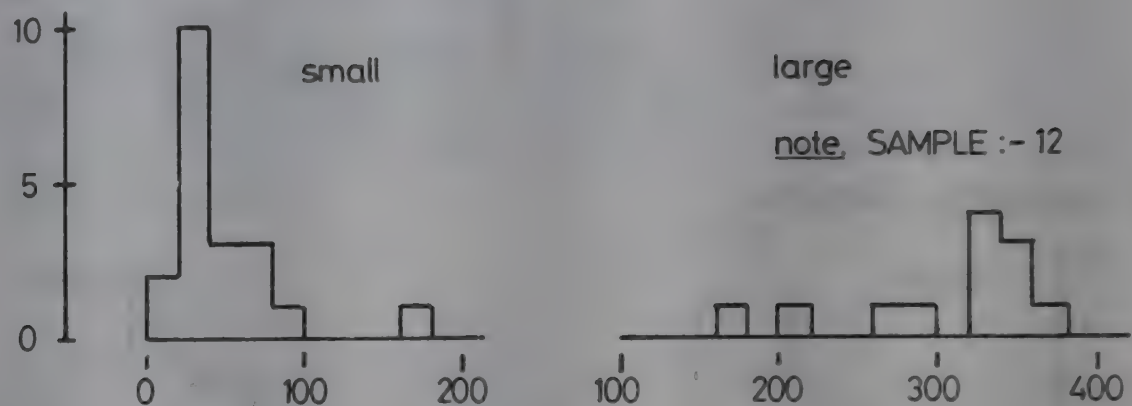


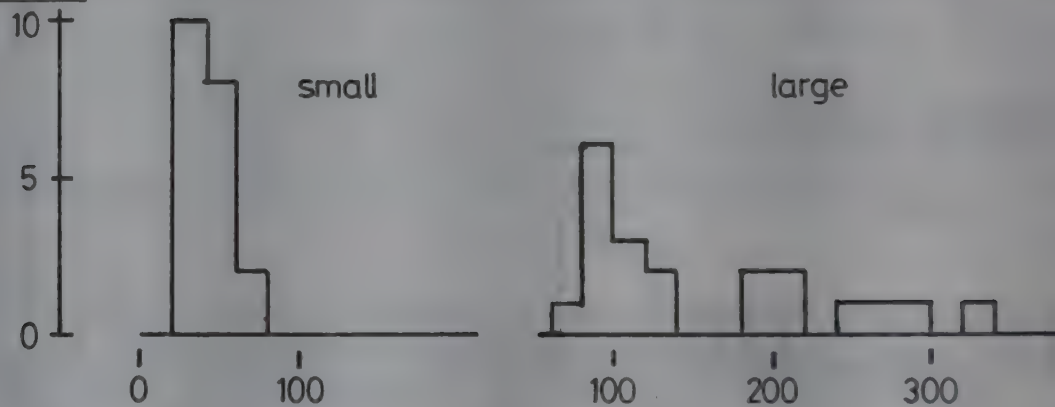
Figure 10 Fish size distribution
Session I

SAMPLE :- 20
WT. IN GRAMS

f) Saurida tumbil



g) Sciaenidae



h) Trichiurus lepturus

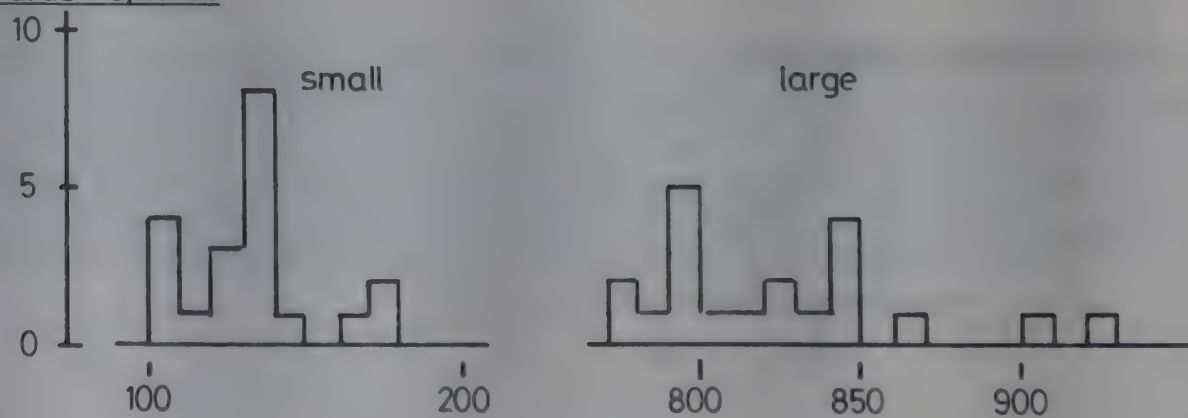


Figure 10 (cont'd) Fish size distribution
Session I

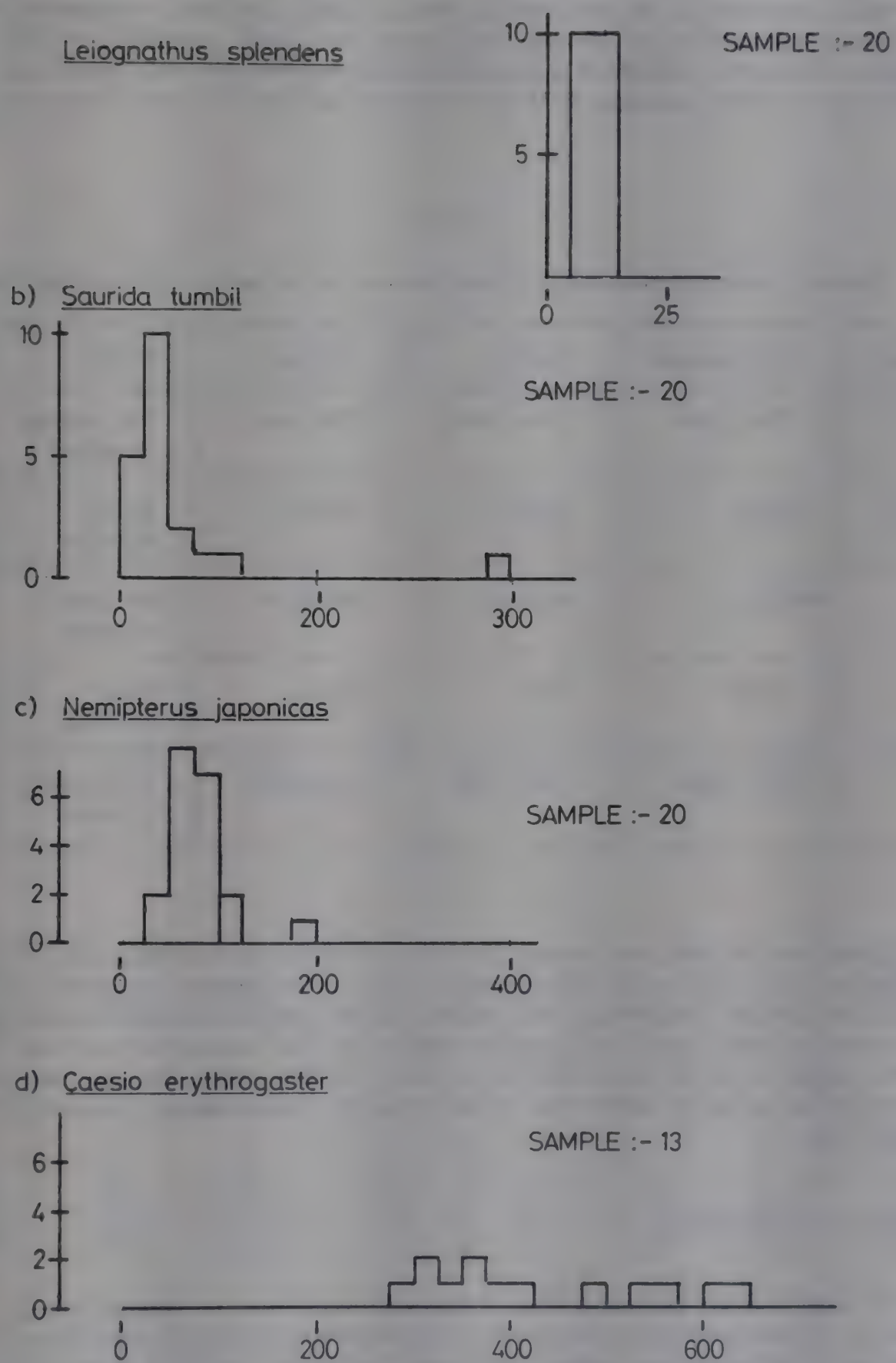


Figure 11 Fish size distribution
Session II

Panel members were asked to mark the appropriate descriptive term on the score sheet for each attribute of each sample tested. A summary of the score sheet is given in Table 1. The term 'cohesiveness' was chosen as best describing the characteristic texture of fish balls. Prior to the taste panel, panellists were told of this; 'rubbery-ness' and 'resilience' were given as words of similar meaning. Comments were freely invited and, although a list of descriptive terms was provided, panellists were encouraged to use any other terms they might feel were more appropriate.

Table 1

Numerical scores corresponding to descriptive terms for each attribute of fish balls

Taste panel score	Appearance	Aroma	Flavour	Texture	Acceptability
9	Very dark	Very strong	Very good	Very strong cohesion	Very good
7	Dark	Strong	Good	Strong cohesion	Good
5	Medium	Moderate	Moderate	Moderate cohesion	Moderate
3	Light	Weak	Poor	Weak cohesion	Poor
1	Very light	Very weak	Very poor	Very weak cohesion	Very poor

For each panel, the fish balls were steamed for 15 min in aluminum foil dishes (16.5 x 9 x 2.5 cm), tightly sealed with aluminum foil. For the fish balls prepared at the research station, five samples of two fish balls of each type of fish and method of separation were presented to the panel at 15-min intervals in random order until all fourteen samples had been tasted. The fish balls made by the local commercial processor were stored in the refrigerator for a minimum of one and a half hours before the taste panels. Steaming and presentation of the samples were carried out as before except that, in this instance, it was possible to present all the samples to the panel at the same time.

Alternative methods of preparation

The use of small fish for the preparation of fish balls would only be possible if they could be prepared quickly and simply for meat separation. *Leiognathus splendens* were obtained from near Kota Kinabalu and stored in ice for 36 h before the preparation studies. The average weight of a randomly selected sample of twenty fish was 24.0 g. One randomly selected batch of 10 kg was beheaded and gutted as in the earlier studies and was passed through the meat separator. The hours of unskilled labour to prepare these fish were recorded, together with the weight of prepared fish and separated meat. Another randomly selected batch of 10 kg of the fish was prepared by cutting the fish in half from just behind the head to just in front of the caudal fin, thus removing the head, belly flaps, internal organs and a portion of the backbone. Details of the man-hour time taken and yields were recorded as for the earlier batch of fish.

Processing details for fish ball production — first taste panel trials

Species and size classification	Method of separation	Percentage yield ^{a/} after separation	Corrected percentage ^{b/} yield for meat	Time to prepare 10 kg fish	Time for manual separation of 10 kg fish	Percentage weight of water added to meat in preparing fish balls
<i>Ariidae</i>						
Small	Mechanical	51	43	1.5	—	None
Large	Manual	54	40	0.8	3.3	None
<i>Leiognathus splendens</i>						
Small	Mechanical	50	34	2.5	—	1.7
Large	Manual	56	36	1.8	5.3	1.8
<i>Nemipterus japonicus</i>						
Small	Mechanical	62	41	3.1	—	5.3
Large	Manual	61	32	2.2	5.7	7.0
<i>Pomadasys argyreus</i>	Mechanical	47	27	6.0	—	2.0
<i>Pomadasys hasta</i>	Manual	56	28	2.1	3.1	1.2
<i>Saurida tumbil</i>						
Small	Mechanical	71	61	2.2	—	None
Large	Manual	71	62	1.4	3.2	1.2
<i>Sciaenidae</i>						
Small	Mechanical	56	46	2.9	—	2.2
Large	Manual	64	49	1.5	2.9	4.0
<i>Trichiurus lepturus</i>						
Small	Mechanical	76	49	1.6	—	None
Large	Manual	74	35	0.9	3.4	2.8

a/ Preparation includes beheading, gutting and descaling (where appropriate)

b/ Correction factor added to meat weight ex-separator to account for the weight of flesh lost in the machine. This factor was calculated from the average weight loss which resulted when 4 weighed samples of minced were passed through the separator

RESULTS

Details of the method of preparation used for the fish balls produced in the research station are given in Table 2. Descriptions of the appearance of the separated flesh after mechanical separation are given in Table 3. Table 4 lists the percentage yield of cleaned fish and separated flesh obtained from those four species of fish used for the second taste panel trials, together with the percentage weight of water, salt and monosodium glutamate added by the fish ball plant manager and comments about the process.

The results of the taste panel trials are shown in Tables 5 and 6. Table 5 gives the taste panel scores for the fish balls prepared entirely at the research centre (Trial 1). It was not possible to offer commercial fish balls to this panel for nonstatistical comparison since they were not available in the market. However, three days later, seven of the original panel members tasted a sample of commercial fish balls but their scores are not listed in Table 5 since the difference in the numbers of tasters might cause misleading comparisons. As a group, these seven tasters rated the appearance of the commercial fish balls lower than those of the mechanically separated *Leiognathus splendens* flesh in the earlier trial. The aroma was rated slightly lower, the flavour higher and the texture and acceptability slightly higher than those for the fish balls from *Leiognathus splendens*.

In general, panellists had some difficulty expressing their views on the fish balls in English and often restricted their comments to general terms such as 'best' or 'sweet'. A comment of particular interest, however, was that the balls made from mechanically separated *L. splendens* would be 'perfect if they had a lighter appearance'. Most comments, however, merely amplified the scores given and were often contradictory.

Table 3

Appearance of separated fish from commonly occurring demersal fish species

Species	Appearance of meat after mechanical separation ^{a/}
Ariidae	Muddy brown colour interspersed with black and brown blood clots
<i>Leiognathus splendens</i>	White colour but with greyish flakes of flesh and particles of belly lining
<i>Pomadasys</i> spp.	Light brown/grey colouring with particles of belly lining
<i>Nemipterus japonicus</i>	Light pink/white colouring
<i>Saurida tumbil</i>	Yellowish white colour with a few pink flakes of flesh and a few particles of belly lining
Sciaenidae	Very light pinkish white flesh with a few red blood clots and some particles of belly lining
<i>Trichiurus lepturus</i>	Greyish meat with red/brown blood clots and some skin pieces

a/ Meat separated mechanically was in all cases darker than meat separated manually and contained more clots and skin/belly lining pieces. After mincing, the colour became more uniform but darker overall for each species

Table 4

Processing details for fish ball production — first taste panel trials

Species	Percentage ^{a/} yield after preparation	Corrected ^{b/} percentage yield of meat	Percentage weight of water added to make fish balls	Percentage weight of salt added to make fish balls	Percentage weight salt added to make fish balls	Comments
<i>Caesio erythrogaster</i>	72	56	14.7	1.6	1.7	Fish balls set within 17 min
<i>Leiognathus splendens</i>	59	45	24.0	1.6	2.0	110 ml water added during mixing — set within 2 1/2 h
<i>Nemipterus japonicus</i>	58	44	15.7	1.5	0.8	105 ml water added during mixing — set within 2 1/2 h
<i>Saurida tumbil</i>	68	54	19.3	1.9	1.8	79 ml water added during mixing — did not set within 2 1/2 h

a/ Preparation includes beheading, gutting and descaling (where appropriate)

b/ Correction factor added was calculated as detailed for Table 2

Table 5
Taste panel scores for fish balls — Trial 1

Species	Method of separation	Appearance	Aroma	Flavour	Texture	Acceptability
<i>Ariidae</i>	Mechanically Manually	6.9 5.7	5.2 5.3	3.3 5.0	1.8 3.1	2.4 3.7
<i>Leiognathus splendens</i>	Mechanically Manually	6.0 6.1	5.4 5.6	6.9 6.3	7.6 7.0	6.9 6.6
<i>Nemipterus japonicus</i>	Mechanically Manually	4.1 4.0	5.8 4.8	5.8 6.4	4.8 6.1	5.4 6.0
<i>Pomadasys argyreus</i>	Mechanically	6.3	5.8	4.6	3.2	4.7
<i>Pomadasys hasta</i>	Manually	4.2	6.1	6.6	4.9	5.8
<i>Saurida tumbil</i>	Mechanically Manually	3.9 2.4	5.0 4.9	5.9 6.7	4.2 5.8	5.6 6.2
<i>Sciaenidae</i>	Mechanically Manually	5.7 3.0	5.6 4.2	4.7 6.3	4.6 5.0	4.4 5.1
<i>Trichiurus lepturus</i>	Mechanically Manually	7.0 4.4	5.2 4.8	4.8 5.2	4.8 5.1	4.4 5.0
Level of significance of handling effect ^{a/}		xxx	n.s.	xxx	xxx	x
Least significant difference between different handling techniques at 0.05 probability level		0.45	0.58	0.46	0.46	0.55
Level of significance of species effect ^{a/}		xxx	n.s.	xxx	xxx	xxx
Least significant difference between species at 0.05 probability level		0.85	1.08	0.86	0.85	1.03

a/ The symbols xxx, xx, x, and n.s. represent variations which are significant at $p < 0.001$, $p < 0.01$, $p < 0.05$ and not significant respectively

Analysis of variance of the results was carried out as 9 tasters x 7 species x 2 handling techniques; *Pomadasys argyreus* had to be considered as a single species with *P. hasta* to enable the analysis to be carried out. The level of significance of handling and species differences for each attribute are indicated in Table 5, together with least significant differences for each attribute at 0.05 probability levels. All attributes other than aroma were found by tasters to differ with handling and fish species at some level of significance. However, because of a highly significant second order interaction between handling, fish species and appearance, the difference in appearance scores between alternative handling techniques and the various fish species used are of doubtful validity. This interaction may be explained by the important effect of particle subdivision on appearance.

Table 6 gives the average taste panel score for those fish balls partially prepared by the local commercial fish ball processor (Trial 2), together with the level of significance derived through analysis of variance and least significant differences at 0.05 probability levels.

Table 6

Taste panel scores for fish balls — Trial 2

Species	Appearance	Aroma	Flavour	Texture	Acceptability
<i>Caesio erythrogaster</i>	4.3	5.3	4.3	3.7	4.8
<i>Leiognathus splendens</i>	7.7	5.1	6.1	7.7	6.2
<i>Nemipterus japonicus</i>	4.4	5.2	5.4	4.2	5.0
<i>Saurida tumbil</i>	4.1	5.8	6.2	5.9	5.3
Level of significance ^{a/}	xxx	n.s.	x	xxx	n.s.
Least significant difference at 0.05 probability level	1.06	1.29	1.40	1.99	1.55

a/ The symbols xxx, xx, x, and n.s. represent variations which are significant at $p < 0.001$, $P < 0.01$, $p < 0.05$ and not significant respectively

In the trials on alternative methods of preparing *Leiognathus splendens* for meat separation, it was found that preparation by cutting the fish in half reduced the time required to prepare 10 kg of the fish from 4.7 to 0.8 h. Although the yield of prepared fish dropped from 57 to 43 percent, the corrected yield of meat from the separator dropped by only 7 percent (from 38 to 31 percent) when the simpler preparation method was used.^{1/} The separated flesh produced by each method differed very little in colour, but that obtained from simply prepared fish contained far fewer pieces of belly lining.

DISCUSSION

The fish balls made of *Leiognathus splendens* at the research centre, either from mechanically or manually separated flesh, had a higher acceptability at a 0.05 level of significance than all other fish balls apart from those of *Saurida tumbil* and those produced from the manually separated flesh of *Nemipterus japonicus* and *Pomadasys hasta*. The attribute for which fish balls produced from *L. splendens* scored particularly well was texture; the score was higher than all other scores to a highly significant level ($p < 0.001$). The next highest score was

^{1/} The corrected yield was calculated from the data in the footnote to Table 2

given for fish balls prepared from manually separated *N. japonicus* although the texture score for these was probably not significantly different ($p > 0.05$) from that of samples made from samples of manually separated flesh of *S. tumbil*. The panel scores for flavour did not vary so widely and, although samples prepared from *L. splendens* again had the highest score, those from *N. japonicus* and *S. tumbil* did not differ significantly ($p < 0.05$) and those prepared from manually separated flesh of Sciaenidae and *P. hasta* also obtained similar scores. Ariidae and *Trichiurus lepturus* both gave fish balls which scored poorly for all the attributes studied; this is rather surprising since Amano (1965) lists this fish as a species which 'sets' readily in the raw state. For most fish species, the use of mechanical rather than manual separation of the flesh led to significantly worse flavour, lower cohesiveness and lower acceptability. However, the length of time required to separate flesh manually from the fish (as indicated by Table 2) makes it inevitable that mechanical separation will replace manual separation in fish ball processing plants.

The three species which consistently scored most highly for flavour, texture and acceptability in the first trials were chosen for the second series of taste panel trials. In the second trial, the wide variation in monosodium glutamate and salt content of the fish balls (Table 4) undoubtedly contributed toward the nonsignificance of the differences in the acceptability scores. Also, it is very unfortunate that the *Caesio erythrogaster* sample was obtained from the market and could not be caught by Fisheries Department staff because the panel scores of fish balls produced from this sample of fish were far lower than those of a sample of fish balls obtained from the market and presented to a previous panel. It therefore seems likely that the sample of fish obtained was of inferior quality and that, since this was the only mix to which the plant manager did not add water during mixing, too much water was added during preparation of the fish balls. Therefore, only limited reliance can be placed on the findings of this taste panel. The flesh from the sample of *Leiognathus splendens* was far darker ($p = 0.001$) than that of the other species assessed; this is not surprising in view of the small size of the fish used (Fig. 2). However, the cohesiveness was again probably significantly higher ($p = 0.05$) than that of flesh from other species assessed apart from that of *Saurida tumbil*. There was great variability in the acceptability scores for *L. splendens* with some tasters marking it highly because of its good cohesive texture and others marking it down because of its dark appearance.

The shortage of raw materials for fish ball production in Kota Kinabalu and the import of foreign fish into Singapore indicate that, in certain cases, an inexpensive alternative source of fish, which would produce a very similar quality of fish ball, is needed. Although these results indicate that certain species of trash fish do give good fish balls, they also indicate problems which must be overcome if trawler by-catch is to be used widely as a raw material for fish balls.

The major problem in using this by-catch would be the time taken to prepare the separated flesh. Meat separators obviously reduce this time markedly and, in spite of their effect on appearance, flavour, texture and acceptability, are already widely used in the industry. In the experimental studies, the time taken to prepare the fish was rather longer than it would have been under commercial conditions because the workers were unskilled and because the fish were descaled. Descaling was necessary for the experimental studies, because of the small size of the fish, to prevent fish scales entering the separated flesh. However, the use of a separating drum with smaller perforations would remove the necessity for descaling. It seems likely that, in any commercial operation, small fish would be merely cut in half, as was done for the sample of *Leiognathus splendens*, since the improved appearance of the flesh and the enormous saving in preparation time would amply compensate for the 7 percent loss in yield from such low-value fish.

If trawler by-catch is to be used to produce high quality fish balls and related products, it is likely that the fish should be blended to combine the best attributes of different species. The dark colour of flesh from small species such as *L. splendens* would probably mean that meat from such fish could only produce very good fish balls if blended with a light coloured flesh such as that from *Saurida tumbil*. With details of the different attributes of each species a plant owner could blend different species.

However, it is known that the properties, of a particular species vary and that occasionally a fish ball mix prepared as normal will not 'set'. If this occurs, it is normal commercial practice in Kota Kinabalu to blend the mix with a mix prepared from fresh fish and then hope that this blended mix will set. The setting phenomenon of uncooked, minced and salted fish muscle has been studied largely by the Japanese, and Amano (1965) states that it is believed to be disadvantageous for the Japanese industry since it is difficult to mould 'set' meat into the shape required for 'kamaboko' or fish sausage. He gives a list of species grouped according to their ease of setting. Studies reported by Okada (1963) indicated that salts added to the minced fish cause hydration of the myofibrillar proteins. The formation of the network structure is due to moderate denaturation of the proteins by the salts. He suggests that the setting of raw fish muscle prior to cooking would permit the use of fish normally regarded as unsuitable for 'kamaboko'. In addition, he states that optimum setting of the fish meat ball will occur at pH 6.0-7.0 and that, for certain fish, maximum jelly strength is obtained by cooking at a temperature of less than 100°C. For the development of the fish ball industry, it would be advantageous to know whether the Japanese findings are applicable under local conditions and whether, with a greater degree of process control over fish ball and fish cake production, it would be possible to make products of a consistently higher quality.

The development of minced fish flesh products is of great importance to Sabah and similar countries in South East Asia for two reasons. In a number of areas, overexploitation of fishing grounds is already occurring, as reported for Thailand by the South China Sea Fisheries Development and Coordinating Programme (1976). Even in Sabah there is some evidence of a declining prawn catch per unit effort and in such a situation, trawler fleet owners are looking for alternative methods of marketing their catch. Also, the relatively high gross national product for countries such as Korea, Malaysia, Singapore and Taiwan (Williams, 1977) is likely to weaken demand for many traditional products. In Sabah, for example, the fermentation of fish with rice, which is a widely used method of preservation in inaccessible interior areas, is rarely, if ever, used in even the smaller towns.

The major development of the market for minced fish products in Japan since the war, as reported by Amano (1965), indicates that there may be potential for a large expansion of the market for minced fish flesh products based on traditional processed foods as increased industrialization and urbanization occurs in these countries. Official assistance in the development of this industry could be given in two ways. First, research stations in the area could conduct trials to investigate widening of the product range, improved preservation methods and how the various factors of cooking temperature, pH, raw materials and additives affect the gel structure and the product quality. Second, in the light of the Japanese experience (Amano, 1965) that minced fish products could have been developed more quickly had extensive use of preservatives been permitted earlier, revision of public health laws on preservatives of fish products could be considered as a means of developing the industry. Meanwhile, the introduction of refrigerated display cabinets to many food shops in the area should permit the wider distribution of existing products.

CONCLUSION

Taste panel trials on fish balls produced from various common species of trawler by-catch indicated that *Leiognathus splendens* and, to a lesser extent, *Nemipterus japonicus* and *Saurida tumbil* gave fish balls with a high cohesiveness. The dark colour of separated flesh from smaller by-catch species of fish would pose a problem in using such fish but it is probable that this could be overcome by blending meats of differing desirable properties. The processing time for small fish from the trawler by-catch can be greatly reduced by using simpler but marginally more wasteful methods of fish preparation and by the use of mechanical meat separators. More work on the factors affecting the successful production of fish balls and related products is required if rapid development of the industry is to occur.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the kind permission of Mr. Chin Phui Kong to proceed with the work, the technical assistance of many fisheries department staff, the advice on the statistical interpretation of the results from Mr. H.A. Bremner and Dr. D.A. Ratkowsky, the helpful comments on the work from Dr. R.G. Poulter and the advice on the fish ball industry in Singapore given by Mr. Tan Sen Min.

REFERENCES

- Amano, K., Fish sausage manufacture. *In* Fish as food, edited by G. Borgstrom. New York, Academic Press, vol. 1965 3:265-80
- Bremner, H.A. and P.J.I. Snell, Chemical taste panel tests on the mechanically separated flesh of six tropical fish 1978 species. Paper presented to the Symposium on fish utilization technology and marketing in the IPFC region. Manila, 8-11 March 1978
- Okada, M., Elastic property of kamaboko (fish meat jelly). *Bull. Tokai Reg. Fish. Res. Lab.*, (36):21-126 1963
- Snell, P.J.I., The trawling industry in Sabah and its non-commercial fish catch. Paper presented to the Symposium 1978 on fish utilization technology and marketing in the IPFC region. Manila, 8-11 March 1978
- South China Sea Fisheries Development and Coordination Programme, An analysis of the present and recommen- 1976 dations for future fishery development and management programmes and institutional arrangement in the Kingdom of Thailand. Manila, South China Sea Fisheries Development and Coordinating Programme
- Williams, M.J., Development cooperation. *In* Efforts and policies of the members of the development assistance 1977 committee. Paris, Organization of economic cooperation and development, pp. 238-9

SALT MINCED FISH TRIALS

by

L.W. Regier, M.B. Wojtowicz, M. Fierheller and S. Varga
Technology Branch, Fisheries Management
Fisheries and Oceans Canada
Halifax, Canada

Abstract

The advent of meat bone separators for providing a minced flesh in high yield from many species presents many new opportunities for fish utilization. Salting of the minced flesh provides a rapid and inexpensive method for preservation.

Salted mince has been shown to require drying or an inhibitor such as sorbic acid to prevent microbial spoilage on long-term storage at ambient temperatures. Initial food-use trials of a dried shredded form in ten countries have met with mixed responses. Generally good acceptance was indicated in those locations which have traditionally used salt fish.

INTRODUCTION

The recent application of meat-bone separators to fish has presented many new opportunities. The bones, which are one of the major objectionable factors in fish for many people, can be effectively removed from fish flesh. Also, greater yields of edible flesh can be obtained from the fish. In cases where the fish are traditionally hand filleted and only the fillet used for food, as much as 100 percent more flesh can be recovered by use of the meat bone separators. The major uses of machine separated flesh have been in the washed and frozen or washed and cooked forms as represented by the surimi and kamaboko of Japan. Since the mincing operation mixes any spoilage organisms throughout the flesh, there is the potential for microbial spoilage that shortens storage life in the wet form. Therefore, methods are needed for utilization and preservation of minced fish flesh that are not dependent upon refrigeration. This is especially pertinent in areas where integrated refrigeration systems for the storage and distribution of food products are not already in place. Salting preservation presents one solution to this problem and a rapid salting technique has been studied in our laboratory as a response to this need.

TRADITIONAL SALTING

When whole or split fish are salted in traditional methods, a period of several days to several weeks is needed for the salt in contact with the surface to dissolve and diffuse into the flesh to fully salt out the proteins. At the same time, of course, there is diffusion of water out of the flesh forming free brine on the surface. At this point of full salting the product is stable for a short time but must be kept cool or it will spoil microbiologically. To further stabilize the traditional salt fish, it is normally dried. Much of the traditional dried salt fish, however, is still not at a low enough water content to make the product biologically stable. During drying, the rate of diffusion of water out of the flesh is normally the limiting factor, for the maximum drying temperature must be kept low or the fish cooks. Also, rapid drying can lead to 'case hardening' in which a crust forms that greatly decreases the rate of drying.

SALTING OF MINCED FISH

There are several different approaches that may be taken in salting minced fish:

- (a) Salting minced in block form. In this approach the minced flesh is formed into a block which is then handled in the traditional way. However, this allows the spoilage organisms in the central portion of the block to act before it is salted.

- (b) Partial salting and drying. Here the mince is mixed with some salt that will be effective in inhibiting some of the spoilage organisms and then it is dried. Since the proteins are only partially salted they form a gel which is very difficult to dry and later to desalt for cooking.
- (c) Full salting of mince. With this approach enough fine salt is mixed with the mince to fully saturate the water which is present in the flesh. Free brine is formed which can be removed efficiently by pressing or centrifuging. This product still is susceptible to the slow spoilage of red bacteria or moulds, for it has the water activity of a saturated salt solution which is equivalent to 75 percent relative humidity.

MICROBIAL STABILITY OF SALT MINCED FISH

Fully salted (equivalent of saturated salt solution) minced fish can be kept free from apparent spoilage by the red bacteria by storage below 8°C. This is essentially what has been done with traditional salt fish in the cool climate areas.

Two methods for prevention of this spoilage were investigated in our laboratories—drying, and addition of sorbic acid. The latter is an approved food additive in many countries.

When salt minced fish was inoculated with cultures of the red bacteria, it was again shown that a level of water content equivalent to 70 percent relative humidity was the limit for growth of the spoilage organism. In our salted minced fish this was at about 24 percent moisture. Thus a product with a moisture level below this was found to be shelf-stable at ambient or slightly abusive temperatures (up to 35°C for many months).

Later studies with sorbic acid added to the salt showed that a level of 0.3 percent sorbic acid (calculated on the wet mince basis) was effective in preventing the spoilage even when the mixture was inoculated with the red bacteria. Using this approach, a non-dried product containing 0.36 percent sorbic acid was shown to be microbiologically stable for several months at 35°C. The product had 40-45 percent water, 24-26 percent salt and 30-35 percent fish solids (mostly protein). When desalted with 10 times its weight of water, the final ready-to-eat material had about 0.1 percent sorbic acid.

PILOT TRIALS

A decision was made to proceed with pilot plant production and feeding trial before the results of the sorbic acid studies were available. The product was thus made using the drying method for preservation. A total of 6 tons of dried salt minced fish was prepared from split cod fish in the pilot plant of the Technology Branch Laboratory. This traditional readily available raw material was chosen for we needed a regular supply in 500 kg lots for pilot plant batches. The product from the pilot plant contained about 20 percent water, 40 percent salt and 40 percent fish solids (mainly protein). It was packaged in laminated foil-polyethylene bags in 1/2 kg quantities.

Through the kind cooperation of the Fisheries Prices Support Board Canada and the World Food Programme, this material was shipped to ten countries for trial.

USE TRIALS

Schools and hospitals were primarily used as the places for preparing and serving this trial product to consumers. The Fisheries Food Centre in Ottawa had prepared a variety of recipes for use of this salt minced fish and these were included with the brochure and questionnaire that was shipped along with the product.

Of the ten locations receiving the product, two were not able to carry out and report the trials as yet. In some of the trials reported, the product was over one year old at time of use.

In the eight reports, four indicated an enthusiastic to very favorable response to the product. Two of the locations indicated the product was acceptable but had some reservations about its use. Finally, two of the locations found the product unacceptable.

The six out of eight acceptable responses in themselves are quite encouraging. However, when we looked closely at the returned questionnaires we noted that the major objections to the salt minced fish came from places where the participants are not normal users of salt fish. There are indications that the salt minced fish was not properly desalted before use in the trials where the product was not accepted. One part of the problem may be the characteristic flavour of salt fish which is at first objectionable to those of us who did not grow up with the product.

These trials have thus shown that it is possible to produce a salt minced fish in good yield by a rapid process. The product is shelf-stable, when protected by packaging, for a long period and is fairly well accepted by consumers throughout the world.

SESSION

VI

SESSION

IV

SESSION VI

FORUM ON EXTENSION SERVICES AND TRAINING PROGRAMMES

CONTENTS

FISH PROCESSING TECHNOLOGY AND EXTENSION SERVICES IN THE PHILIPPINES by Anselma S. Legaspi	608
EDUCATION AND TRAINING IN FISH HANDLING AND PROCESSING by Mn.N. Clifford, G.B. Debling and J.G. Garbutt	633
PROBLEMS AND PRACTICES IN FISHERIES TRAINING AND EXTENSION: AN AUSTRALIAN VIEW by H.E. Rogers	652
FISHERIES EXTENSION IN RURAL DEVELOPMENT: PROBLEMS AND PROSPECTS by R.C. Cole	655
EDUCATION AND TRAINING FOR DEVELOPING COUNTRIES: ACTIVITIES IN IUFOST by J.F. Kefford	659
B.S. MAJOR IN FISH PROCESSING TECHNOLOGY AT THE UNIVERSITY OF THE PHILIPPINES by P.T. Arroyo, L.M. Santos and L.S. Mendoza	664
ESTABLISHMENT OF POST-HARVEST TECHNOLOGY RESEARCH IN THE MARINE FISHERIES RESEARCH DEPARTMENT, SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTRE by Southeast Asian Fisheries Development Centre, Singapore	677

FISH PROCESSING TECHNOLOGY AND EXTENSION SERVICES IN THE PHILIPPINES

by

Anselma S. Legaspi
Bureau of Fisheries and Aquatic Resources
Manila, Philippines

Abstract

Although the fishing industry is rapidly expanding and fish production is increasing, the rate of technological transfer from research institutions to the industry is rather slow. This has prompted the Government to launch a massive extension service in fish processing.

To date, there are 72 full-time and 25 part-time extension workers assigned at the 12 Regional Office of the BFAR. Extension services are available on request in the form of lectures, demonstrations, technical assistance, training seminars, conferences and also through mass media.

The fish processing methods usually demonstrated are the following: fish smoking canning, salting, curing, fermentation, bangus (milkfish) deboning and the preparation of snack items.

The ultimate objective of fish processing technology is to eliminate wastage in the handling, processing, marketing and distribution of fish, to develop import substitutes and to expand and develop export markets.

INTRODUCTION

Fish processing industries in the Philippines are rapidly expanding with constantly increasing fish production. From the traditional methods the industry has expanded into modern fish processing. Modern technology has been introduced through foreign assistance, either in the form of study and training grants abroad or through experts who give technical advice on technology to both Government and private sector. As technology is adopted, the Government sees to it that the industry maintains and/or improves the quality of its products through technical assistance and inspection services. Nevertheless, the application of this technology is limited to the big establishments, usually those exporting their finished products.

In general, the adoption of modern technology is rather slow as most of the processing plants operate on a small scale and have not deviated from traditional processing methods. Being aware of this slow pace of technological transfer, the Government has taken steps to keep pace with modern developments. Research laboratories and educational institutions have geared fishery projects toward applied research and development. Results of these researches are transferred to the industry through different information systems but the most recent and effective approach is through extension.

BACKGROUND

A fish processing extension service is not new in the country; its origin can be traced back to the establishment of government fishery schools in the forties. However, the fish processing extension service was limited to demonstrations conducted by fishery students and Government employees either independently or as

part of demonstrations on food processing and nutrition. In the past, although significant changes in fish processing technology have gradually been introduced in the country, the transfer of developed technologies to the industry was rather slow. This may be attributed to one or a combination of the following factors:

- (1) Lack of trained manpower for extension service;
- (2) Lack of the necessary capital to adopt modern technology;
- (3) Resistance to change on the part of the industry particularly those which operate on a small scale;
- (4) Insufficient attention to the quality of processed fishery products both by producers and consumers. Hence, processors do not feel the need to improve their products;
- (5) Lack of coordination between research institutions and the industry. Hence, research programmes do not reflect the needs and problems of the industry; this results in the non-application of research results;
- (6) Filipino culture and tradition continue to play a role in people's food behaviour.

To keep pace with the fast tempo of technological advancement both here and abroad, the Government launched an intensive extension programme. This will ensure that the 12 Regional Offices have extension workers who can help narrow the gap between the Government and the private sector by transferring technological advances from research institutions (both local and abroad) to the industry.

The official take-off of the massive extension service in fish processing was 1971 when the Government, through a joint venture of the Bureau of Fisheries (now Bureau of Fisheries and Aquatic Resources, BFAR) and the National Food and Agricultural Council (NFAC), started courses on Trainers' Training on Communication and Extension Teaching Methods. The Bureau's technical personnel from all the three aspects of fisheries participated, i.e., Inland Fisheries, Marine Fisheries and Fish Processing.

Five fish processing technologists participated in this two week course and a month later they organized and implemented a training programme for fish processing extension workers. This programme, entitled 'Training on Fish Processing and Communication and Extension Teaching Methods', was held at the Bureau's Pilot Processing Plant at Mercedes, Camarines Norte (Region V). This month-long course had more than 40 participants representing the different Regional Offices and the Central Office. After the training all the participants went out to do extension work throughout the country. Since then, fish processing extension workers have been rendering extension services throughout the country.

THE EXTENSION SERVICE: CURRENT SITUATION

To date, the fish processing extension service has around 72 full-time and 25 part-time extension workers assigned at the 12 BFAR Regional Offices all over the country (Appendix 1). A breakdown of the extension service by Region, is shown in Appendix 2.

Form

In most cases, extension service is given to requesting parties usually in the form of one or more of the following:

- (1) Lectures and/or demonstrations;
- (2) Technical assistance and/or consultancy;
- (3) Training seminars or conferences;
- (4) Mass media, either through publication of research results or through radio and television.

Lectures and/or demonstration

Lectures and demonstrations on the different methods of fish processing are given mostly at the request of interested parties. Such lectures and demonstrations are usually given to schools, universities, institutions, societies and other civic organizations as well as to the general public during trade fairs and during Fish Conservation Week.

The fish processing methods usually demonstrated are the following:

- (a) Fish smoking, both ordinary and soft-boned smoked milkfish;
- (b) Fish canning;
- (c) Fish salting, curing and fermentation;
- (d) Bangus (milkfish) deboning;
- (e) Preparation of fish cakes, sausages and rolls;
- (f) Preparation of snack items like shrimp kroepcke, spicy dilis (anchovy), fish polvoron, squid rings, sea cucumber sitsaron, etc.

In addition to the above-mentioned fish processing methods, demonstrations are usually preceded by a short lecture on fish handling and nutrition.

A fish cooking contest is also being sponsored by the Bureau during Fish Conservation Week. This contest aims to create awareness among housewives and fish consumers on the importance of fish in the diet and to encourage the utilization of cheap species of fish and shellfish in the preparation of both ordinary and special or fiesta recipes. The contest is open to the general public and cash awards are given to winning entries.

Lectures and demonstrations on fish handling, marketing and distribution have now become a part of all fisheries training programmes, not only those conducted by the Bureau but also those sponsored by SEAFDEC and even in workshops sponsored by the private sector like the Federation of Fish Producers.

Some of the fisheries training programmes where lectures and demonstrations on fish handling, marketing and distribution were incorporated in their course design are as follows:

1. Prawn Culture Training: sponsored by SEAFDEC/BFAR which has already trained five groups of government technicians, private fish pond owners and cooperators. Each group comprised 30-40 participants;
2. ASEAN Training Course in Freshwater Fisheries: participants from Indonesia, Malaysia, Singapore, Thailand and the Philippines;
3. Fisherman's Training at Sangley Point, Cavite City: from 1975 to present it has already trained more than three hundred fishermen with 40-60 participants per group (six months course).

Technical assistance and/or consultancy

Technical assistance is usually given to people engaged in the fish processing industry, to fishpond owners, to fishermen and to fish exporters. Technical assistance is usually on fish handling, processing, preparation of feasibility studies and in-plant demonstrations on proper handling of fish during transport, pre-processing, processing and also during marketing. Similar services, such as inspection, quality control, etc., deemed necessary for the growth and development of the industry, are also being given. Such technical assistance is delivered through field visits, office calls, written communications, telephone calls, personal calls, during the inspection of fish processing plants and also through media.

Training seminars or conferences

(a) On-the-job training of students from schools, colleges and universities, particularly those taking fish processing technology and food technology, is undertaken by the Bureau throughout the year. This training usually lasts for one month but may be shorter if the requesting party so desires and prepares the prospective graduates for future employment. During this training period they are given the chance to do fish processing work in actual job situations. They are also given lectures on fish handling and nutrition and on the principles involved in each step in the different fish processing techniques. The students are also taught to prepare project feasibility studies. They are required to submit a report at the end of the training period. Every year the Bureau trains 80 to 120 graduating students from different colleges and universities.

(b) A one week intensive training seminar on fish processing is conducted by the Bureau for housewives, businessmen and the general public. This seminar is formal; the participants (groups of 15-25), attend six days from 09.00 to 17.00 h. After training, a certificate of attendance signed by the Director is awarded to those participants who attended continuously.

During the training, different fish processing techniques are demonstrated to the group who in turn do the actual processing. The fish and other ingredients are provided by the participants who take home their finished products. This method of extension service differs from the lecture-demonstration approach because the students are not only made to appreciate the techniques but to attain the performance level through 'learning by doing'. The programme is as follows:

	<i>Morning</i> (09.00 to 12.00)	<i>Afternoon</i> (13.00 to 17.00)
Day 1	Registration Orientation: Policies of BFAR Organization of class	Lectures: Fish handling and nutrition Patis and bagoong preparation
Day 2	Practical: Patis and bagoong preparation Lecture/demonstration: Deboning bangus	Lectures: Fish cakes and rolls Fish smoking
Day 3	Practical: Fish cakes and rolls Fish smoking	Lectures: Fish canning
Day 4	Practical: Fish canning Deboning bangus	Lectures: Canning (continued) Shrimp kroepack
Day 5	Practical: Shrimp kroepack Relleno Spicy dilis	Recapitulation and course evaluation
Day 6	Presentation of certificates	

This programme is conducted at the Bureau of Fisheries and Aquatic Resources' demonstration booth at Nayong Filipino, Pasay City. For the past two years, around 20 groups of students (more than 300), have been trained, some of whom are now engaged in small-scale cottage industries.

The training is undertaken mainly by Central Office Fish Processing Personnel. However, some of the Regional Offices have already started similar training and eventually, as the Bureau expands and decentralizes, all Regional Offices will be conducting similar training.

(c) Training of fish processing extension workers and fish quality inspectors is conducted by the Bureau of Fisheries and Aquatic Resources under the administration and supervision of the Fisheries Training Division. These trainees are employees of the Bureau. On fish processing, at least three courses have already been conducted in the past six years, not to mention those who have undergone training abroad. The three courses conducted by the Bureau are the following:

1. Fish Processing and Communication and Extension Teaching Methods (1972): 40 participants;
2. Fish Quality Control and Inspection (1975): 25 participants;
3. Communication and Extension Methodologies, Fish Handling and Processing Techniques (1977): 41 participants.

Participants of these courses are now working in different parts of the country. More than 60 per cent of fish processing extension workers have undergone technical training. The profile and place of assignment of fish processing extension workers are shown in Appendix 1.

Mass Media

Research results are disseminated to the public through the Philippine Journal of Fisheries and the Fisheries Newsletter. Other technical matters of interest to the general public are also published in the daily newspapers. Radio and television interviews with BFAR officials take place especially during Fish Conservation Week, the third week of October.

Constraints

In spite of all the efforts and approaches to extension, the transfer of technology from research institutions to the industry is still slow. Fish handling practices throughout the catching and distribution chain have barely improved. In most cases only those who produce for export markets handle their fish in the right manner. Improved fish processing techniques are usually adopted by big processing plants; the small-scale fish processing establishments, which absorb more than 35 percent of the total fish production, stick to their generally unhygienic and outmoded fish processing techniques, sacrificing product quality to the detriment of the consuming public. This situation exists and remains unchecked due to several factors. First and foremost is the economic factor which has prevented the processors from improving their processing area. In most cases there is no separate processing area; part of the house is utilized as a working area. Processing methods employed are usually those that were handed down from generation to generation. Improvements involve extra cost and there is little incentive to change.

Fish processing extension workers have attempted to introduce change in the technologies presently employed. The usual reason for non-adoption is 'lack of capital'. For this reason, the extension workers have

reversed the approach; instead of introducing change to the producers they are trying to educate the consumers. The rationale behind this approach is 'if the consumers demand quality products, then producers would give them what they want or else they will have no market'. Although this cannot be claimed to be the right approach, this has somehow helped to spread the gospel of correct fish handling and processing techniques.

In recent years, the fish processing industry, particularly where products are intended for export, started to adopt technological advances. With the demonstrated benefits derived from the technology adopted, other processing plants are expected to follow but this move on the part of the small-scale industry needs a massive extension education programme. This is where an extension service in fish processing is urgently needed.

To follow the trend of technological advancement, and its subsequent transfer and application to the industry, the Bureau of Fisheries and Aquatic Resources launched its Five-Year Extension Programme, part of which is the fish processing extension programme.

FISH PROCESSING EXTENSION PROGRAMME, 1977-1981

Objectives

The objectives are:

- (1) To encourage the private sector to adopt newly developed technologies in the handling, processing, packaging and marketing of fish;
- (2) To promote import substitution and the development of export products;
- (3) To conduct an information drive on fish handling and quality control to prevent unnecessary waste;
- (4) To help the private sector explore and expand local and foreign markets for fish and fishery products.

Strategies

To attain the objectives, fish processing extension efforts will be intensified by attempting to cover every municipality and city in each province. In the first year of the programme, each Regional Office will determine priorities, in terms of extension requirements of its cities and municipalities based on the number of fish processing plants and volume of fish production. By the fifth year of the programme, most of the cities and/or municipalities in each region would have been covered.

Form

Extension services will be in the following form:

- (1) Technical assistance in the form of seminars, lectures and demonstrations not only to requesting parties but also to those actually engaged in the industry such as fishermen, fish processors, fish vendors, teachers, students, housewives and the general public.
- (2) Training of extension workers, housewives and businessmen will be conducted at strategic places throughout the year. This training will be given in groups of 15-25 persons for six days and a certificate of completion will be issued. The topics to be covered will be fish handling, processing and marketing and fish in nutrition.

- (3) On-the-job training of students from different fishery schools, colleges, and universities will also be given. Such training will be conducted for one week to three months depending upon the request of the respective school official. At the end of the training period, students will be required to submit a report.
- (4) Pilot-scale processing or manufacture of different fish and fishery products will be demonstrated by extension workers at the Bureau's existing processing plants. This will encourage the private sector to engage in commercial production thereby promoting import substitution.

Targets

The target for fish processing extension service is for every extension worker to cover at least 12 cities and/or municipalities every year, making sure that in every municipality at least eight barrios are covered monthly. The breakdown of regional targets is shown in Table 1.

The effectiveness of the extension service will be measured by:

- (1) The number of newly developed and/or improved methods of processing introduced and adopted by each province/region;
- (2) Increase in percentage utilization of fish caught, thus decreasing waste;
- (3) People's awareness of the extension service being tendered by fish processing extension workers;
- (4) Increase in exported fish and fishery products;
- (5) Improved methods in marketing and distribution of fish and fishery products.

Projects

To carry out the programme for CY 1977-1981, the BFAR Fish Processing Extension force will pursue the following:

- (1) Technical assistance on fish processing in the form of lectures and demonstrations and helping the industry to solve their problems in fish technology. Everyone engaged in the industry, such as fishermen, fish processors, fish vendors, teachers, students, housewives and the general public will be included.
- (2) Seminar/workshops on fish processing — for extension workers and the private sector.
- (3) Training of students, extension workers and housewives at strategic places throughout the year.
- (4) Pilot processing demonstration plants are to be established and operated by BFAR. These plants will be located in strategic areas for fish processing development at Sta. Ana, Cagayan, Mercedes, Camarines Norte, Carigara, Leyte, Zamboanga City, Salay, Misamis Oriental and Davao City. These plants will hopefully encourage processors to adopt new techniques and innovations and will be integrated with the operation of ice plants and cold storage facilities of the BFAR.

Through these pilot programmes the BFAR will encourage the development of large, new processing plants. Establishment of canneries near freshwater and brackishwater fisheries will also be encouraged. This will help satisfy the country's demand for canned fish, currently imported from other countries.

- (5) A continuing evaluation of the BFAR fish processing extension service will be conducted. Such evaluation will be used for future training projects and for requests for additional personnel.
- (6) Extension workers would render technical assistance to fish processors and give them guidelines on the proper handling and processing of their products. Services rendered by the extension workers would be primarily advisory with the regulatory functions left to the inspectors.
- (7) Extension workers will give technical advice on the proper handling of fish and fishery products during transport and distribution to local and foreign markets. The proper use of ice, proper containers, correct packaging and transport facilities will be explained and/or demonstrated to fish handlers.

TRENDS IN PROSPECTS OF THE EXTENSION SERVICE

Research institutions or laboratories

Research institutions or laboratories form the foundation of extension services without which the system would not exist at all. The importance of this relationship between research and extension cannot be overstated, for research has established the scientific foundation on which sound technology must be based.

In effect, the output of these research institutions or laboratories becomes the input of the extension service. In the Philippines, a number of Government agencies and educational institutions are engaged in fish processing technological research; among them are the following:

- (1) Bureau of Fisheries and Aquatic Resources (BFAR);
- (2) Food and Nutrition Research Institute, NIST, NSDB;
- (3) Philippine Atomic Energy, NSDB;
- (4) Food Terminal Incorporated;
- (5) University of the Philippines;
- (6) Some private companies and educational institutions.

The results (particularly of applied research) of the research institutions are first pilot tested by the Fish Processing Section, Fisheries Extension Division, BFAR, before they are taught to the extension workers who in turn disseminate to the private sector. Consequently, the rate of technological transfer is greatly influenced by the rate of research turnover. Nevertheless, extension does not only depend on locally researched technology but also on imported technology, applied to the local situation.

One overriding factor in the adoption of transferred technology is 'relevance', that is, the introduced technology must be relevant to the current and future problems of the industry. Unless the industry feels the need to change their present technology, no adoption will take place. Hence, it is important for those involved in research to be aware of the way the industry works. They should be in close contact with the industry. Burgess, referring to the people involved in research, puts it this way: 'unless staff are widely experienced, they cannot be expected to talk on the same terms or perhaps even to understand the nature of the questions asked. The result is likely to be that industry will not seek the advice of the laboratory which will become more and more concerned with other, less relevant programmes' (Burgess, 1975).

Table 1
Regional targets and extension worker for
fish processing programme, 1977-1981

Region	Existing number of cities and municipa- lities	1977		1978		1979		1980		1981	
		Exten- sion workers	Targeted cities and municipa- lities	Exten- sion workers	Targeted cities and municipa- lities	Exten- sion workers	Targeted cities and municipa- lities	Exten- sion workers	Targeted cities and municipa- lities	Exten- sion workers	Targeted cities and municipa- lities
I	135	5	25	5	60	6	72	7	84	8	96
II	113	3	15	3	36	5	60	6	72	7	84
III	126	4	20	4	48	5	60	6	72	7	84
IV	244	12	60	12	144	13	156	14	168	15	180
V	106	13	60	13	106	13	106	13	106	13	106
VI	135	12	60	12	135	12	135	12	135	12	135
VII	140	1	5	1	12	2	24	4	48	6	72
VIII	141	0	0	0	0	2	24	4	48	5	60
IX	85	10	50	10	85	11	85	11	85	11	85
X	126	4	20	4	48	5	60	6	72	7	84
XI	81	7	35	7	81	7	81	7	81	7	81
XII	93	1	1	1	12	3	36	5	60	7	72
	1,525	72	250	72	611	85	899	95	1,031	105	1,139

a/ Full-time extension workers only

Problems and needs of the industry

An extension service can be effective only if the technology extended is adopted by the industry. Inasmuch as industry adopts technology relevant to its problems and needs, the extension services, to be effective, must be responsive to the needs and problems of the industry.

The fish processing industry in the Philippines is still developing and is beset with many problems: economic, financial, technical and socio-cultural. It has been mentioned that the foremost reason for non-adoption of introduced technology by the industry is financial; this is particularly true of small-scale industries.

For this reason, any introduced technology that would entail expense would surely encounter resistance. Considering that the needs of the industry are for hygiene and sanitation, and for improvement of present handling practices and processing techniques, there seems to be a great challenge ahead for the extension worker. How can they bring about change without using capital? The answer is simple, 'technological change through an economic approach' but the solution may be technological research with cost-benefit analysis. A very simple example is the problem of quality in handling fresh fish. Most fish handlers do not add sufficient ice because that would mean additional investment. But if it can be proven through concrete data based on research and cost-benefit analysis that the increase in the selling price of good quality fish is much more than their additional investment, then adoption of the technology introduced would surely gain headway.

This strategy may be applied in introducing modern technology but it should be coupled with financial assistance or information on how to obtain credit facilities offered by local banks. Assistance on marketing would also be attractive to the industry. Research and extension services cannot do these things in isolation.

Future prospects

A breakdown of the fish processing extension coverage is shown in Appendix 2. Practically everybody or anyone who in one way or another handles or consumes fish should be a target of the extension worker. This is because the ultimate goal of a fish processing extension is to eliminate wastage in handling and processing of fish, to develop and expand export markets and to cut down the importation of fish and fishery products by encouraging local manufacturers to produce import substitutes.

For the fish processing extension service to be effective and able to attain these goals, it is imperative for the extension workers to be able to convince their audience to adopt the technology that they are introducing. To attain this, an intensive programme is needed; additional manpower with appropriate education and/or training and experience will also be needed.

In the future, extension workers are expected to assist aboard the fishing vessels, at fish landings, fish markets, at the processing plants and also in schools, colleges and universities and even in the homes of fishermen and non-fishermen alike. They will not just spread the gospel of technological advances but will also ensure that adoption of transferred technologies leads to improved and developed industries.

With the Government's effort to establish fishermen's cooperatives or Samahang Nayong, the fish processing extension workers will join efforts with the cooperative movement and make use of the organization. Each extension worker will be assigned a certain number of fishermen's cooperatives to cover.

Socialized approach

The strategies and approaches to effective extension services may be summed up as an interdisciplinary or socialized approach. The approach is socialized in the sense that the extension worker will have to work closely with the researcher, the economist, the nutritionist, the fishermen, the processors and the housewives and more specially, with the industry as a whole. This is not an easy job but, if accomplished, will be rewarding, not personally (to the extension worker) but to the people's way of life and to the economy of the whole country.

REFERENCES

Burgess, G.H.O., The contribution of fish technology to the utilization of fish resources. *In* Fishery products, 1974 edited by Kzcuzev, pp.47-53

Philippines, Bureau of Fisheries and Aquatic Resources, Accomplished report. Manila, Bureau of Fisheries and 1976 Aquatic Resources

_____, Report on evaluation of the BFAR Fish Processing Extension Service, 1977
1977

_____, Fisheries statistics of the Philippines. *Fish.Sta.Philipp.*, 1977
1977a

_____, Four-year expanded programme
1978

_____, Fisheries extension programme, 1977-8
1978a

Profile of fish processing extension workers

Name	Position	Qualifications	Status of Appointment	Length of Service (years)	Training/Seminar Attended
<i>Region I</i>					
1. Maxima Biagtan	Fishery Biologist	Assoc. in Fisheries	Permanent	4	Technical training
2. Luzviminda Macaranas	Fishery Technologist	B.S. Food Nutrition	Permanent		Technical training
3. Cornelia Madayag	Sr. Fishery Technologist	Assoc. in Fisheries	Permanent	12	Technical training
4. Leonida Rosario	Fishery Aide	B.S.E. Ed.			Without training
5. Experanze de Vera	Fishery Technologist	Assoc. in Fisheries			Technical training
<i>Region II</i>					
1. Aurora Agatep	Jr. Fishery technologist	Assoc. in Fisheries	Temporary	10	Technical training
2. Jovita Ayson	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	7	Technical training
3. Felicitas Caligdong	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	7	Technical training
4. Francisco Salazar ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent	1	Technical training
5. Nelly Tabbu ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent	1	Technical training

^{a/} Part-time extension worker

*Region III*1. Alice Castaneda^{a/}2. Gloria Cayanan^{a/}3. Arcangel Cruz^{a/}

4. Mamerta Ecunar

5. Lourdes Florentino^{a/}

6. Leonida Poquiz

7. Helen Zafranco

Region IV

1. Filomena Agustin

2. Anita Barican

3. Elisa Caldito

Jr. Fishery biologist	B.S.E.	Permanent	5	Technical training
Jr. Fishery biologist	B.S.H.E.	Temporary	12	Technical training
Fishery technologist	B.S. Pharmacy	Permanent	5	Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Permanent		Technical training
Sr. Fishery technologist	B.S. Pharmacy	Permanent	5	Technical training
Jr. Fishery technologist	Assoc. in Fisheries			Technical training
Sr. Fishery technologist	Assoc. in Fisheries	Permanent	17	Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Permanent	2	Technical training
Jr. Fishery technologist	B.S.E.	Temporary	29	Technical training
Fishery extension specialist II	Assoc. in Fisheries	Permanent		

^{a/} Part-time extension workers

4. Alice Castaneda	Jr. Fishery biologist	Assoc. in Arts; B.S.E.		5	Technical training
5. Cleofas Faylona	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	21	Technical training
6. Patricia Haguian	Jr. Fishery technologist	B.S. Nutrition	Permanent	7	Technical training
7. Asuncion Ledesma	Sr. Fishery technologist	B.S. Fisheries	Permanent	10	Technical training
8. Magdalena Moriente ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries			
9. Rebecca Necessito	Fishery tech.	Assoc. in Fisheries			
10. Ma. Eden Ombao	Jr. Fishery technologist	B.S. Fisheries	Permanent	1	Technical training
11. Josefa Pascual	Jr. Fish technologist	B.S.H.E.	Permanent	11	Technical training
<i>Region V</i>					
1. Genoveva Advusario ^{a/}	Fishery Aide	High School Graduate	Permanent	19	Technical training
2. Lourdes Balean	Jr. Fishery technologist	B.S. Fisheries	Temporary	2	Technical training
3. Primitiva Boringot	Jr. Fishery technologist	B.S. Fisheries	Temporary	1	Without training
4. Romana Botilo	Jr. Fishery technologist	B.S. Fisheries	Temporary	2	Technical training

a/ Part-time extension workers

5. Nelly Carlos	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	7	Technical training
6. Leticia Collantes		B.S. Fisheries			
7. Josefina Delfin	Fishery tech.	B.S. Fisheries	Permanent	4	Technical training
8. Aida Domantay	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	11	Technical training
9. Cecilia Formento	Jr. Fishery technologist	B.S. Fisheries	Permanent	1	Technical training
10. Felicidad Gonzales	Jr. Fishery technologist	B.S.E.	Permanent	6	Technical training
11. Perlita de Guzman	Jr. Fishery technologist	B.S. Fisheries	Temporary	1	Non-Technical training
12. Fe Perez	Jr. Fishery technologist	B.S. Fisheries	Temporary	2	Technical training
13. Milagros Supnet	Sr. Fishery technologist	B.S. Zoology	Permanent	11	Technical training
14. Trinidad Toriente	Jr. Fishery technologist	B.S. Fisheries	Temporary	2.5	Technical training
Region VI					
1. Dolores Banaylo	Fishery Ext. Specialist I	Assoc. in Fisheries	Permanent	7	Technical training
2. Angelina Dela Cruz ^{a/}	Fishery Aide	3rd year B.S.E.	Permanent	8	Technical training
3. Teresa Dideles	Fishery Biologist	B.S. Chemistry	Temporary	4	Technical training

4. Marie Amelie Franco	Sr. Fishery technologist	B.S.H.E.	Permanent	4	Technical training
5. Clara Ganzon	Jr. Fishery technologist	Assoc. in Fisheries	Temporary	4	Non-Technical training
6. Brenda Garcia	Fishery Ext. Specialist I	Assoc. in Fisheries	Permanent	2	Without training
7. Clarynda de Guzman	Jr. Fishery technologist	Assoc. in Fisheries			
8. Lilia Jolo	Jr. Fishery technologist	Assoc. in Fisheries			
9. Dolores Hupeda ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent	5	Without training
10. Wenono Lazarte ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent	1	Without training
11. Marcelo Lopez	Supvg. Fish Ext.	Assoc. in Fisheries	Permanent	7	Technical training
12. Josephine Montero ^{a/}	Jr. Fishery technologist	B.S. Food Tech.	Permanent	4	Without training
13. Thelma Rolinas ^{a/}	Fishery technologist	B.S. Pharmacy	Permanent	4	Without training
14. Remigio Rubio	Fish. Ext. Sp. II	Assoc. in Fisheries	Permanent	7	Technical training
15. Lilia Salarda ^{a/}	Fish. Ext. Sp. I	Assoc. in Fisheries	Permanent	4	Non-Tech. training
16. Mathilde Salazar	Fish. Ext. Sp. II	B.S. Chemistry	Permanent	12	Technical training
17. Angelica Sitaca ^{a/}	Sr. Fishery technologist	B.S. Chemistry	Permanent	6	Technical training

^{a/} Part-time extension workers

18. Mercedita Sta. Maria	Jr. Fishery technologist	B.S.E. Ed., Assoc. in Fisheries	Temporary	5	Technical training (inland)
19. Herminia Valles	Jr. Fishery technologist	Assoc. in Fisheries			
<i>Region VII</i>					
1. Roman Bajos ^{a/}		Assoc. in Fisheries			
2. Teresita Lazarte	Jr. Fishery biologist	B.S. Med. Tech			Technical training
3. Josefina Lopez ^{a/}	Sr. Fishery technologist	B.S. Fisheries	Permanent	11	Technical training
4. Aniceta Dela Pena ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent		Technical training
5. Trinidad Saga ^{a/}		Assoc. in Fisheries			Technical training
6. Carmelita Tachoy	Jr. Fishery technologist	Assoc. in Fisheries		4	Non-Technical training
<i>Region VIII</i>					
1. Felicula Aclao ^{a/}	Sr. Fishery technologist	Assoc. in Fisheries	Permanent		Technical training
2. Editha Dollizon ^{a/}	Jr. Fishery technologist	Assoc. in Fisheries	Permanent		Technical training
3. Dionisia Gabales ^{a/}	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	5	Technical training
4. Leticia Otadoy	Jr. Fishery technologist	Assoc. in Fisheries	Permanent		Technical training

a/ Part-time extension workers

Region IX

1. Hamsatul Abtani

2. Edna Cabanatan

3. Rosella Contreras

4. Karuna Iraj

5. Georgina Loquias

6. Delia Navales

7. Crisanta Ruste^{a/}

8. Clarita Sabtula

9. Annabella Sy

10. Emerita Taup

11. Sophia Wali

Region X

1. Olivia Kintana

Jr. Fishery technologist	B.S. Fisheries	Temporary	1	Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Temporary	1	Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Permanent	5	Non-Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Temporary	1	Without training
Jr. Fishery technologist	Assoc. in Fisheries	Temporary	1	Without training
Jr. Fishery technologist	Assoc. in Fisheries	Temporary	5	Without training
Sr. Fishery technologist	Assoc. in Fisheries	Permanent	11	Technical training
Fishery Demons.	B.S.H.E.	Permanent	11	Without training
Sr. Fishery technologist	Assoc. in Fisheries	Permanent	4	Technical training
Jr. Fishery technologist	Assoc. in Fisheries	Temporary	4	Without training
Jr. Fishery technologist	Assoc. in Fisheries	Permanent	5	Technical training
Sr. Fishery technologist	B.S. Med. Tech	Permanent	4	Technical training

2. Erlinda Paculba	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	Technical training
3. Epifania Pedimonte	Jr. Fishery technologist	Assoc. in Fisheries	Temporary	Without training
4. Salome Zagado	Sr. Fishery technologist	B.S.E.	Permanent	Non-Technical training
<i>Region XI</i>				
1. Trofina Delasante	Sr. Fishery technologist	Assoc. in Fisheries	Permanent	Technical training
2. Hanida Fernandez	Fishery Tech.	Assoc. in Fisheries	Temporary	Technical training
3. Rosa Fernandez	Jr. Fishery technologist	Assoc. in Fisheries	Temporary	Technical training
4. Evelyn Lerios	Jr. Fishery technologist	Assoc. in Fisheries		
5. Frediberto Santella	Jr. Fishery technologist	B.S.E., Assoc. in Fisheries	Permanent	Non-Technical training
6. Erlina Sisante	Fishery Tech.	B.S. Med. Tech.	Permanent	Technical training
7. Esmaelita Tejero	Jr. Fishery technologist	B.S.E., Assoc. in Fisheries	Temporary	Technical training
8. Edna Vidal		Assoc. in Fisheries	Permanent	Technical training
<i>Region XII</i>				
1. May Abdua ^{2/}	Fish Ext., Sp. I	Assoc. in Fisheries	Permanent	Technical training
2. Halkat Napii	Jr. Fishery technologist	Assoc. in Fisheries		

Appendix 2

Coverage of the fish processing extension service

Region	Provinces covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoma & Fishermen Served*
					tonnes	ranks				
I	Pangasinan	45	2	2 084	19 469	1	1	19 124	320	
	Dagupan City			225						
	San Carlos City			118						
	Ilocos Sur	32		872	5 254	2		8 387	7	
	Ilocos Norte	19	1	537	2 163	3		6 611	8	
	Laog City			113						
	La Union	20		686	3 399	4	1	4 032	6	
	Mt. Province	10		155	309	5		485		
	Abra	22		328	309	6		670		
	Benguet	13	1	298		7				
	Baguio City			203						
	Sub-total	161	4	5 619	3 30 903		2		341	
II	Cagayan	29		1 022	6 544	1	5	13 482	81	
	Isabela	34		1 234	820	2		5 019	10	
	Batanes	6		32	163	3		689		
	Ifugao	7		153	134	4		172		
	Quirino	5		115	64	5				
	Kalinga-Apayao	15		275		6				
	Naeva Vizcaya	12		343		7		1 049		
	Sub-total	108		3 174	7 725		5	20 411	91	
III	Bulacan	24		1 261	8 332	1	1	6 111	95	1 (80)
	Bataan	12		372	7 895	2	1	6 101	57	1 (40)
	Nueva Ecija	29	3	1 216	5 821	3		7 220	39	
Continued										

* Fishermen served are the numbers in parentheses

Appendix 2 continued

Region	Provinces Covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoma & Fishermen Served
					(tonnes)	(tank)				
	Cabanatuan City Palayan City San Jose Zambales Olongapo City Pampanga Angles City Tarlac	13 21 17 17	1 1	202 29 83 435 233 1 144 221 809	3 195 1 784 1 599	4 5 6	1	3 615 10 528 2 976	28 30 25	1 (70)
	Sub-Total	116	5	6 005	28 626		3	36 587	274	3 (190)
IV-A	Batangas	32	2	1 206	12 815	5	4	7 364	20	1 (43)
	Batangas City			184						
	Lipa City			141						
	Cavite	19	3	720	9 229	7	1	5 172	91	3 (268)
	Cavite City			140						
	Tagaytay City			22						
	Trece Martirez City			13						
	Laguna	29	1	1 142	45 922	1		6 063	17	2 (87)
	San Pablo City			224						
	Marinduque	6		254	4 385	10	4	4 994	7	
	Occ. Mindoro	11		252	6 135	8	2	3 157	37	3 (171)
	Orr. Mindoro	15		570	10 826	6		5 934	5	
	Palawan	19	1	470	29 266	2	4	6 365	5	
	Puerto Princesa City			77						
	Quezon	47	1	1 747	26 955	3		13 405	117	
	Lucena City			165						

Continued

Appendix 2 continued

Region	Provinces Covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoma & Fishermen Served
					(tonnes)	(rank)				
	Rizal	14		612	19 129	4		7 329	79	2 (61)
	Romblon	14		251	5 184	9		4 933	2	
	Sub Total	206	8	8 190	169 956		15	64 716	296	11 (590)
VI	Metro Manila	13	4	7 723			1		93	
	City of Manila								73	
	Pasay City								18	
	Quezon City								39	
	Caloocan City								9	
	Sub Total								232	
V	Albay	17	1	981	9 460	5	7	6 403	39	
	Legaspi City			132						
	Camarines Norte	12		440	2 772	6	1	3 623	124	1 (44)
	Camarines Sur	35	2	1 225	21 923	3	5	12 173	54	1 (22)
	Iriga City			91						
	Naga City			118						
	Catanduanes	11		350	32 659	1		5 016	5	
	Masbate	21		681	23 772	2	3	11 002	177	
	Sorsogon	16		737	9 842	4	3	9 028	39	
	Sub Total	112	7	4 755	100 428		20	47 245	378	2 (66)
VI	Aklan	17		472	3 288	5	3	4 099	44	
	Antique	18		664	11 365	3	1	8 201	10	
	Capiz	16		596	10 098	4	1	6 184	105	
	Iloilo	46	1	2 181	15 440	2	13	10 974	180	
	Iloilo City			449						

Continued

Appendix 2 continued

Region	Provinces Covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoops & Fishermen Served
					(tonnes)	(rank)				
	Negros Occidental Bacolod City Cadiz City Bago City La Carlota City San Carlos City Silay City	25	6	1 437 467 87 108 63 133 131	21 631	1	11	11 340	184 4	2 (60)
	Sub Total	122	7	6 788	61 822		29	40 798	528	2 (60)
VII	Bohol Tagbilaran City	46	1	1 218 72	49 862	2	3	18 622	45	
	Cebu Cebu City Lapu-Lapu City Mandaue City Toledo City Danao City Negros Oriental Bais City Kanlaon City Dumaguete City Siquijor	49 22 6	5 3	1 783 714 83 117 94 71 848 74 32 155 139	63 125 10 617	1 4	6 7	624 912 7 341	41 7	
	Sub Total	123	9	5 400			16	650 876	93	

Continued

Appendix 2 continued

Region	Provinces Covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoma & Fishermen Served	
					(tonnes)	(rank)					
VIII	Eastern Samar	23	2	618	3 835	3	10	10 525	75	1 (20)	
	Leyte	24		1810	10 174	1		16 119	11		
	Ormoc City			167							
	Tacloban City		177								
	Northern Samar	3	608	3 759	4	7 969					
	Western Samar	22	1	773	5 407	2	3	13 165		1 (20)	
	Calbayog City	18		516			4				
	Sub Total	110	3	4 669	23 175		17	47 778	86		2 (40)
	Basilan	7		203	26 965	4	2	21 323	119		
	Sulu	14		348	36 965	1	1		4		
Tawi-Tawi	10	192			5						
IX	Zamboanga Del Norte	18	2	542	17 691	3	2	5 417	72		
	Dapitan City			70				15 430	117		
	Dipolog City			76							
	Zamboanga Del Sur	30	998	22 596	2	7					
	Pagadian City		99								
	Zamboanga City			395							
	Sub Total	79	4	2 923	77 252		14	42 170	336		
X	Agusan Del Norte	10	1	235	4 249	4	1	2 275	5		
	Butuan City			174							
	Agusan Del Sur	13		309		7					
	Bukidnon	21		635	2 923	5		1 315	1		
	Camiguin	5		77	2 099	6		1 100			

Continued

Appendix 2 concluded

Region	Provinces Covered	Municipalities	Cities	Barangays	Fish Production		Fish Landings	Fishermen	Fish Processing Plants	Fishcoma & Fishermen Served
					(tonnes)	(rank)				
XI	Misamis Occidental	13	3	380	15 534	2	2	5 473		
	Oroquieta City			67					1	
	Ozamis City			119					1	
	Tangub City			56					19	
	Misamis Oriental	24	2	496	6 832	3	5	4829	4	
	Cagayan de Oro City			206						
XII	Gingong City	26	1	111	32 997	1		10 176	4	
	Surigao Del Norte			507					1	
	Surigao City									
	Sub Total	112	7	3 372	64 634		8	25 168	36	
	Davao Del Norte	19		875	7 716	5	3	2 649	7	
	Davao Oriental	11		394	11 924	4	2	2 293	4	
XII	Davao Del Sur	13		590	21 025	1	3	4 192	7	
	Davao City			796						
	South Cotabato	16	1	631	13 411	3	1	16 382	24	1 (50)
	Gen. Santos City			141						2 (100)
	Surigao del Sur	19		476	20 343	2	1	4 844	6	1 (50)
	Sub Total	78	1	3 903	74 419		10	16 382	24	2 (100)
XII	Lanao Del Norte	19	1		4 635	3		4 939	2	
	Iligan City			159	3-347		1			
	Lanao Del Sur	34	1	1 452	12 652			7 020		
	Marawi City			143						
	Maguindanao	16	1	477	6 489	2		4 858		
	Cotabato City			121	6 489		2	4 858	9	
XII	North Catabato	14		701	6 489			4 858		
	Sultan Kudarat	11		294	6 489			4 858		
	Sub Total	94	3	3 347	23 776		3	16 817	12	
	TOTAL	1 421	58	58 145	786 320		142	1 028 257	2 756	22 (1 046)

EDUCATION AND TRAINING IN FISH HANDLING AND PROCESSING

by

M.N. Clifford, G.B. Debling and J.G. Garbutt
Department of Science and Food Technology
Grimsby College of Technology
Grimsby, U.K.

Abstract

It is desirable that subsistence fishermen and labourers in a fish processing plant should, even at a simple level, have some understanding of the reasons why certain procedures are preferable. This means, however, that instructors must have a sound grasp of the fundamentals to facilitate interpretation in simple language. At the other end of the spectrum, it is desirable that the industrial specialist does not operate in isolation, for example, the microbiologist should be aware of chemical methods of assessment as well as handling and processing techniques.

The training of extension workers, fishery instructors, technologists and research staff requires specialist lecturers and facilities and, above all, time. The authors pay particular attention to the content and organization of one-year intensive study courses. Teaching objectives with associated rational and minimum facilities for such training are identified. The need to develop a balance between basic practical expertise and theoretical understanding is discussed, primarily with respect to fish microbiology, fish chemistry and handling and processing; reference is made to quality control and refrigeration engineering. The problems, and possible solutions, associated with teaching multinational groups, so relevant to second and third country training, are discussed.

INTRODUCTION

The need to improve methods of preservation and distribution of fish is generally appreciated. It is therefore surprising that many people involved in fisheries have never received either any formal tuition explaining spoilage, or training in handling or preservation. It is suggested that everybody in any way involved in fisheries should have some grasp of the fundamentals of fish spoilage as well as instruction in good handling practices. Of course the ability of the fishermen, the labourers on the beach and in the processing unit to understand something of fish spoilage depends very much on local conditions: folklore, superstition, education and extension facilities. A great responsibility falls on the shoulders of the fishery officer, the instructor and the factory supervisor to ensure not only that correct procedures are followed but also that the labourer/fisherman has some idea why it is the correct procedure. While many examples could be quoted to demonstrate the problems that arise through poor understanding of the fundamentals, only one example is presented: 'The value of icing fish has been well promoted with some limited success. However, many fishermen and others involved in handling fish (including fishery officers) seem to think that ice is like a lucky charm which scares away the evil spirits. The larger the lump of ice the better. Intelligent men will argue that large pieces of ice are preferable as the rate of melting is slower and the fish will be cooled on arrival. It can take a long time working from basic principles to convince them that the slower melting of the larger ice only demonstrates less effective cooling of the fish and therefore a more rapid rate of spoilage.'

For the purposes of this paper it is considered that individuals concerned with fish handling may work in one of two extreme situations or a combination thereof. At one extreme there is the fishery primarily concerned with supplying the local community, where any attempt to improve handling and preservation should involve no more than basic rural technology, while at the other is the export-based operation which requires the more sophisticated technology of, for example, freezing and canning. In the first case the key word to success is 'adapt'; adapt existing techniques, adapt existing facilities, adapt other people's techniques. In the second case there is no choice but to 'adapt' the techniques of processing and control laid down by the potential customer. However, from a training and education point of view, the link between the two situations is 'understanding': without understanding there can be no truly successful adaptation of existing methods.

This paper considers the education and training of first line management and above; the fishery officer, the master fisherman, the fisheries instructor, the factory supervisor and the new graduate recruited to the government laboratory. Only if these people have a good, sound grasp of the fundamentals of spoilage and the principles of preservation will they be able to adapt, adopt and translate this understanding into simple dialect to guide the local fisherman.

The training requirement of the various groups will differ. It is contended, however, that before handling and processing techniques can be considered, a knowledge of the fundamentals of fish spoilage, both chemical and microbiological, is required. The degree or depth will reflect the subsequent study of handling and processing techniques and, in certain cases, it may be necessary for a limited number of individuals to specialize in either chemical analysis or fish microbiology. Except in a limited number of instances, the individual will need to apply in the field what has been learnt in the classroom. Effective reporting is equally important to guide one's colleagues. Our experiences of practising fishery officers, etc., from all over the world have been that very few have any real knowledge of the causes of spoilage in fish and even fewer understand the principles of fish preservation. It is even rarer to find a man confident of his ability to carry out a practical investigation and produce a clear, concise report. Practical work and preparation of written reports should be an integral part of any programme of training.

FISH MICROBIOLOGY

With the increase in international trade associated with fish and fishery products, there is an increasing requirement for personnel working in the industry who have some knowledge and training in microbiological aspects of fish and fishery products. Such personnel can be conveniently divided into the following categories:

- (a) Those requiring a peripheral knowledge of microbiology in relation to fish spoilage and preservation;
- (b) Those (food technologists) who required a more detailed knowledge of this subject area, not only in relation to fish spoilage and preservation but also an awareness of laboratory tests and of standards and their implications;
- (c) Microbiologists who are capable of carrying out routine quality control analyses on fish and fisheries products and related materials in an efficient and competent manner.

The education and training of such personnel is no easy task, particularly in dealing with students of variable background and with a variety of paper qualifications. Levels of competence and confidence may bear no

relationship to apparent qualifications, and laboratory skills of even a basic nature may be absent or poorly developed. In view of this, any training programme should be based on fundamental understanding and acquisition of basic skills and, for the person who hopes to gain specialist knowledge in microbiology, some knowledge of peripheral areas of information that impinge on his work. It is our considered opinion that a training programme involving the acquisition of specific skills without fundamental understanding is inadequate to fulfil present requirements, particularly in microbiology.

Training the microbiologist

It is suggested that the training programme should consist of an initial programme of lectures and practical exercises designed to bring all the students to a minimum standard in terms of basic skills, e.g. aseptic technique and theoretical knowledge required as background for future applied work. This initial programme should allow the lecturer to remedy any deficiencies that may exist in those students with previous microbiological experience. An outline of this initial training is set out below:

Theoretical

Nomenclature and classification of micro-organisms;

Methods of studying structure;;

Structure, reproduction and life cycles of relevant micro-organisms;

Growth;

Nutrition;

Environmental factors influencing growth;

Serology;

Survival of micro-organisms under adverse environmental conditions;

Microbial metabolism. Those features relevant to an understanding of fisheries microbiology.

Practical

Preparation and sterilization of media;

Microscopy and staining techniques. Gram stain, spore stain, capsules, motility;

Biochemical tests;

Anaerobic methods;

Influence of pH, temperature, a_w etc., on growth;

Examination of water: plate count, MPN for coliforms, membrane filtration, roll tube. *Streptococcus faecalis*, *Clostridium welchii*. EIMVIC tests. TVCs. Pour plate, spread plate, roll tube, Miles and Misra;

Isolation, enumeration and identification of the following:

Coliforms/Escherichia coli

Faecal streptococci

Staphylococcus aureus

Bacillus cereus

Clostridium welchii

Enrichment, isolation and identification of *Salmonella* including sero typing; *Vibrio parahaemolyticus*;

Examination of surfaces for microbial contamination;

Examination of canned and frozen products;

Examination of shellfish.

The following aspects should be generally incorporated into the programme:

Safety in microbiology laboratories;

Laboratory design and provision of ancillary services;

Equipment for microbiology laboratories;

Sterilization of media apparatus and the disposal of contaminated materials;

Media preparation and design;

Maintenance of culture collections.

This initial work should be followed by a programme of applied study dealing with fish and fishery microbiology. Emphasis in the practical programme should be on quality control procedure and lectures should be designed to integrate with this as well as deal with other areas of microbiological interest, e.g., fish spoilage and preservation.

While ICMSF techniques are important, others should be introduced where appropriate. The practical programme, being designed to achieve a very high degree of skill and competence, should involve the following:

(1) Demonstration of new techniques by lecturing staff;

- (2) Individual or group practical work and the constant checking of skills by lecturing staff;
- (3) Producing laboratory reports including presentation and interpretation of data and application of standards where applicable;
- (4) Discussion of practical work and reports;
- (5) Examination of samples containing an unknown microbial flora by techniques chosen by the student and pursued on an individual basis with the application of specific standards. An outline of such a programme is given below:

Microflora of the aquatic environment;

Bacterial flora associated with the spoilage pattern of: shellfish (crustacean and molluscan), marine fish and freshwater fish;

Polluted waters and fish contamination;

Cleansing of shellfish;

Faecal indicators;

Microbial pathogens in fish, food poisoning and the detection of microbial pathogens:
Staphylococcus aureus, *Clostridium*, *Salmonella*, *Vibrio parahaemolyticus*, *Shigella*;

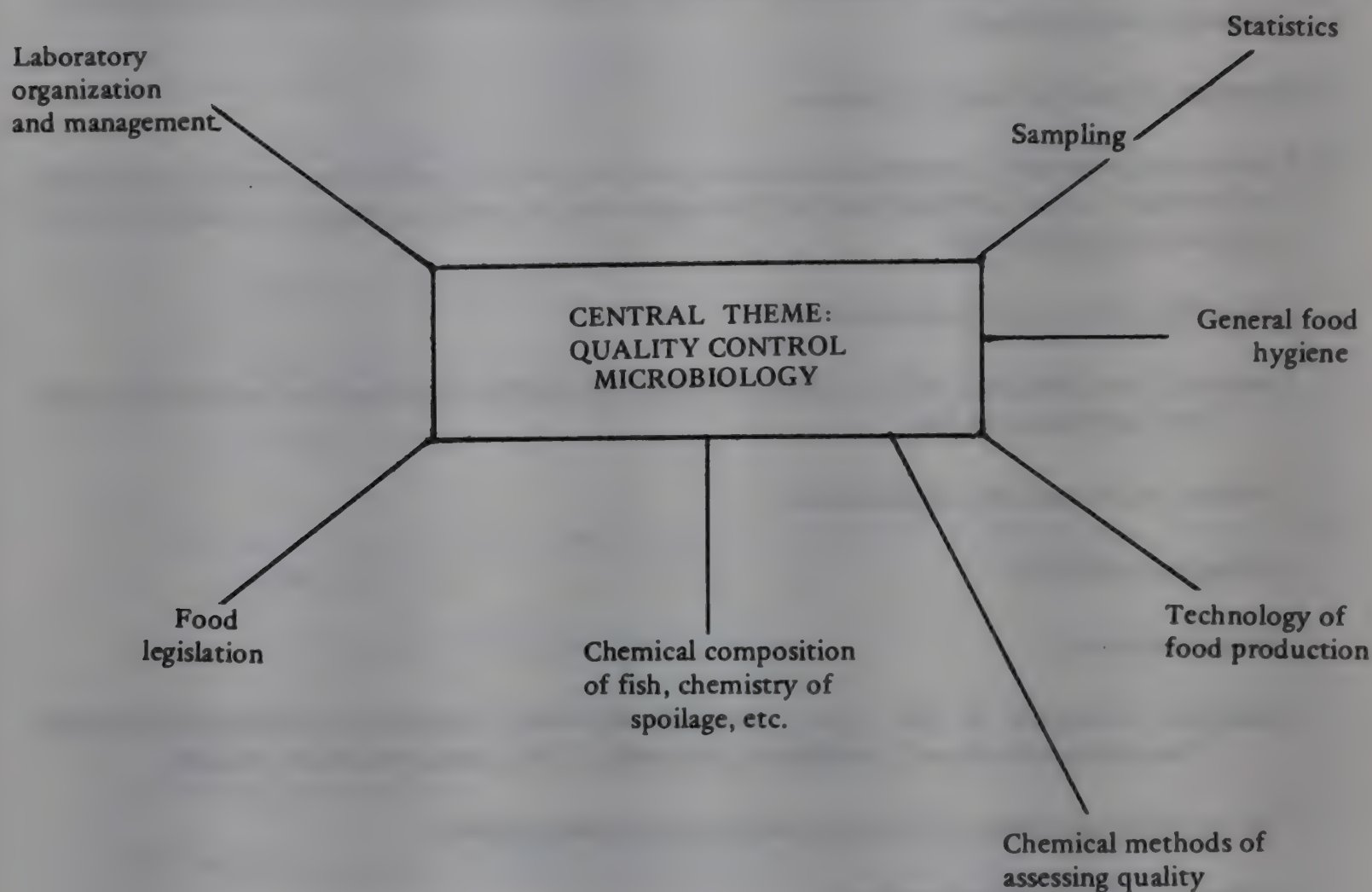
The microbiological basis of fish preservation and processing hygiene;

Hygiene in fish processing/handling.

For the student specializing in microbiology as a central theme, other areas of study which amplify the basic course and place microbiology in relation to other technological areas, are worthy of study (see diagram below).

In our opinion the successful completion of the course would give the student sufficient knowledge and practical skill to fulfil the overall course objectives, i.e.:

- (1) Carry out routine microbiological assessment of fish and fisheries products in an efficient and competent manner;
- (2) Capable of working without supervision;
- (3) Capable of teaching himself new techniques and adapting to new methods;
- (4) Capable of passing on information and discussing the results of microbiological tests in a meaningful way.



FISH CHEMISTRY

In this subject area a requirement for four types of training can be recognized. At the simplest level, only background information should be provided to, for example, fishing-vessel crew or instructors in catching methods. The objective is to give them an understanding of why fish spoilage occurs and why particular handling methods minimize the spoilage and enhance the value of the catch. Little reference should be made to changes occurring after the fish have been sold and practical work should normally be restricted to demonstrations perhaps with participation. There should not be any practical analytical work.

First level of specialization

The objective at this level is to produce a technically competent person who would be able to perform a routine analysis (e.g., moisture, salt, total nitrogen, total volatile nitrogen, etc.) obtaining valid and reliable data, present these in a clear and concise manner, and in a normal situation act upon the results. By virtue of a knowledge of the rationale of the methods employed and significance of the results, such a person should be capable of recognizing abnormal situations and of initiating action to remedy the fault. Normally such action would involve the person's superiors but, in their absence, such a person should be capable of instituting corrections.

The precise material covered in lectures and practical work should take into account whether the person will work mainly with rural technology or whether a more sophisticated knowledge is required to cope with export market specifications. Bearing this point in mind, it is suggested that, typically, the following topics should be covered.:

- (1) Composition, nutritive value, analysis;
- (2) The properties of enzymes and their role in fish spoilage and in fishery byproducts such as FPC and silage;
- (3) An outline of the typical changes occurring *post mortem* in the muscle of true fish, including reference to factors influencing the rate and extent of these changes, various abnormal changes, and brief reference to crustacean muscle;
- (4) Fat rancidity: an outline of the causes and methods of limiting such deterioration;
- (5) Chemical methods of quality assessment referring mainly to those suited to extension work (e.g., total volatile nitrogen by microdiffusion and trimethylamine by ion-sensitive electrode) but including more sophisticated methods where appropriate. In all cases the limitations of the procedure and the significance and interpretation of the results must be discussed;
- (6) Organoleptic assessment and taste panel training and operation;
- (7) The use of the Torry meter.

It is essential that practical training should cover the correct handling and disposal of reagents that are potentially dangerous by reason of their toxic, flammable or corrosive nature. It should also cover the correct operation of balances and pH meters, colorimeters/spectrophotometers and refractometers in some instances, and the correct handling and cleaning of glassware. The requirement for competence with such basic operations is not restricted to this one discipline and any student progressing to any technical specialization should receive such training and can conveniently do so by studying basic fish chemistry. For a student to achieve competence at this level requires:

- (1) A skilled and experienced tutor;
- (2) Access to a wide range of equipment;
- (3) The services of technical staff and servicing personnel;
- (4) A timetable permitting considerable practical experience;
- (5) A willing and conscientious student.

Further details of items 2 and 3 are given in Appendix 2 since these items are often most difficult to obtain in third world countries.

A student should progress to higher levels of specialization in fish chemistry only if he achieves a good standard in this first level.

Arising from our experience in training students to achieve this first level of specialization, two particular difficulties have been encountered regularly:

- (1) Students often have practical experience and ability considerably less than their academic experience, a situation becoming more pronounced the higher the level of academic achievement;
- (2) Even if students are competent in performing practical exercises, they have relatively little experience in processing the immediate results and preparing a report.

This disparity in practical and academic experience can lead to potentially embarrassing situations with status-conscious students. For example, our intake of students in any one year will include a technically experienced but academically unqualified person, and a student with an apparently good first or even second

degree but with little practical experience. Inevitably the 'unqualified' person initially performs practical work more rapidly and competently; such a situation requires tactful handling to prevent the development of counter-productive antagonisms. Such a situation is perhaps more likely to involve older students since, on the one hand, they have had more time to gain (albeit imperfect) practical experience by trial and error and, on the other hand, to lose what little expertise they had while following an administrative career.

The second situation (2) probably arises partly from inadequate training and partly from the enforcement of strict areas of responsibility where the immediate results are passed to a superior for processing. Assuming gradual promotion during an individual's career, one wonders how the superior gained his expertise in processing and interpreting the immediate results. As an example, a student analyzing salt-cured fish for salt content might report the salt content as '4.9 cm³ of 0.1 M silver nitrate' without making any allowance for sample weight, sample dry mass content or any dilutions made during extraction or analysis. Inevitably there is no attempt to indicate the significance of that particular quantity of silver nitrate; indeed standing in isolation as it does, it has no significance.

Second level of specialization

An additional objective at this level should be to impart an ability for systematic investigation, innovation and critical comparison and to use basic statistical methods as a tool. To be successful at this level requires more than a willing and conscientious student. The exact requirement defies description; it is not simply a greater academic ability, rather a particular type of ability which in itself requires an inquisitive nature.

At this level, students should be required to perform speculative analyses, using methods which have not yet gained general acceptance as for example in quality assessment, ultimately comparing their performance with an appropriate established method. Compared criteria should include total costs, repeatability, reproducibility and effectiveness in achieving a particular objective. Such people should also be able to find suitable methods in the literature and to gain expertise fairly rapidly in performing them, and to guide and supervise people of less experience.

The lecture content should cover those items listed in the first level of specialization but in greater depth. The following are examples of greater depth:

- (a) A consideration of how apparently minor changes in methodology markedly alter the results obtained using non-stoichiometric chemical methods as illustrated by the measurement of trimethylamine;
- (b) Discussion of the causes of gaping and chalkiness in muscle *post mortem*.

Additional areas of study should include:

- (1) The chemistry of naturally occurring pigments and of discolorations;
- (2) The chemistry/biochemistry of flavour, odour and texture of fresh and processed fish;
- (3) A typical glycolysis pathway in molluscs;
- (4) Pathways of nucleotide catabolism *post mortem* and methods of measuring catabolites; significance of the catabolites;
- (5) Chemical aspects of smoking, canning, irradiation, etc., including an outline of wood pyrolysis and non-enzymic browning reactions.

Third level of specialization

The main objective at this level should be to train a person to recognize the need for research, to search the literature thoroughly, to plan and perform the research and to interpret and apply the results. There is relatively

little demand for such specialization, such personnel frequently being restricted to government-financed research institutes. A student aspiring to this level of specialization in fish chemistry should complete a major project in the same area and would very probably progress to a master's degree by research.

The key to success at this level is not sheer intelligence; rather a requirement for patience, clear and logical thinking, perseverance and systematic thoroughness.

Formal lecturing should be placed largely by tutorials where the material covered in level 2 lectures could be discussed in more detail. The student should be required to search for literature on selected topics and prepare fully referenced reports and to present these orally to fellow students and staff. In both tutorial and practical exercises emphasis should be placed upon the need for 'validity in research', use of replicates and controls, the problems of artefact production and the limitation (specificity, repeatability, reproducibility) of analytical procedures.

FISH HANDLING AND PROCESSING

As has already been indicated, it is desirable that a study of fish handling and processing should be preceded by a study of the chemical and microbiological aspects will probably not be completed before commencing work on fish processing. However, he or she should have progressed far enough to have a grasp of the fundamentals of spoilage and particular the factors which influence microbial growth and the relationship between temperature and spoilage. Such preliminary work may be accompanied by a study of the fundamentals of food the overall objectives of the course. For example, there would be little processing techniques to be considered and the overall objectives of the course. For example, there would be little point in providing instruction in the use of humidity charts and tables if the individual is not interested in the production, distribution or storage of dried products. A list (not comprehensive) of possible areas of study is to be found in Appendix 3.

It is considered important, however, that all are introduced to the concepts of specific heat, latent heat and steady state heat transfer. The successful cooling of fish by the use of ice and other methods, and the maintenance of chill and frozen temperatures in the tropics depend on an understanding of these fundamentals. Everybody involved in the chain between the point of harvest and the consumer needs to be aware of these considerations. The transference of heat and the heat capacitance of fish are both important to many aspects of fish handling and processing so that preliminary study, perhaps simultaneous to the spoilage of fish, is desirable. One other aspect that is worthy of the attention of most fisheries personnel is that of temperature measurement. A particularly important point is how to use thermocouples and thermistors to measure the temperature of fish.. It may also be desirable to know how to make and calibrate thermocouples, while the processing specialist should know more about temperature recording equipment. In Appendix 3 there is an indication of essential fundamental knowledge for each area of study and a second list of associated study for the specialist.

Study of the fundamentals identified should prepare the individual for subsequent consideration of the arguments for and against all aspects of fish handling, and ensure an ability to consider critically the effectiveness of present post-harvest handling procedures and to assess the value of published information. For each specific method of processing, a general description of the process should be supplemented with a detailed study of the limitations of the process and a critical assessment of the adverse effects of mismanagement.

It is only at the labourer/craftsman level that it is really productive to learn a specific processing technique utilizing a particular piece or range of equipment. For the supervisor, adviser, potential instructor, etc., it is far better to dwell on the fundamental supported by:

- (i) A general study of the processing technique/equipment:
- (ii) A training in reading and interpreting operating instruction;
- (iii) A practical programme designed to build up confidence in operating plant and equipment in general.

This has important implications as far as the training establishment is concerned. It is better to train the craftsman/labourer in the work situation. On the other hand the training establishment for more senior levels should not be equipped with full-scale examples of the industrial process. Fundamentals, principles and examples can be taught and demonstrated more satisfactorily on simple pilot-scale equipment, perhaps not specifically designed for fish processing, where the teacher and student have to use imagination and inventiveness. This applies particularly to the more sophisticated technology but is equally important, for example, in smoking, where it is better for the student to analyze the limitations of a kiln made out of an oil drum than produce superior products with little effort in a forced convection, electrically heated unit. Further, it is our observation that where industrial-scale equipment has been installed for teaching purposes it is rarely run, or else the commercial demands of ensuring a saleable end product from the large quantity of raw materials required interferes with the learning process (occasional commercial exercises can be worthwhile).

To identify equipment and facilities for the subject area is difficult as they must reflect the local interest. The best investment is thermocouple temperature measurement equipment, sufficient for each group of two students to be able to measure at least three temperatures simultaneously. Fish preparation equipment should be available with hygiene in mind. The publication by Rogers *et al.*, (1975) 'an illustrated guide to fish preparation,' is useful here. Remembering that the subject should be taught in association with fish chemistry/microbiology, a lot of equipment in Appendix 2 will be of value in studying fish processing (e.g., balances and ovens to monitor drying processes). For rural technology, it is important to have sufficient supplies of local building materials; the student should be expected to build the equipment and so training in welding, carpentry, etc., may be required. Probably ice-making, freezing, chill and cold store facilities would be required by all establishments. Ideally the refrigeration equipment should be fully instrumented but this does not negate having a small experimental refrigeration rig for practical purposes. If canning is to be considered, not only is seaming, retorting, steam-raising, water-cooling equipment required but also specialized thermocouples and meters to monitor the temperature history within the can should be available. Such facilities require specialist technician support and an on-going budget for replacement and repair.

Finally, a few points concerning the organization of fish handling and processing practicals. It is likely that an establishment would have sufficient facilities for students to gut and fillet fish simultaneously should that be considered desirable. Possibly there may be sufficient equipment for students, working in pairs, to monitor the rate of cooling of fish iced by various methods. However, in the case of chilled or refrigerated sea water, smoking, freezing, canning, etc., facilities are bound to be limited. It is preferable that the students should work in pairs but each group carrying out different exercises. This creates difficulties in terms of time-tabling and supervision (no more than four groups to a supervisor) with the possibility of practical work being carried out before the theory is complete. This is infinitely preferable to a large number of students watching one or two of their colleagues carrying out the work.

The aim of the practical session should be not only to demonstrate the theory, but also to ensure that at the end of the course the student is capable of interpreting a short briefing into a programme for practical investigation, liaise with his colleague to ensure quick but efficient completion of each stage, note the results and collect all relevant data, produce a concise report accompanied by relevant calculations, graphs, tables, and comment on the relevance and validity of the results. This should be the basic requirement of everybody who may be involved in applying fish handling and preservation techniques in the field. The difference is in the fundamental understanding which is reflected in the initial brief.

Thus, to summarize, the aims associated with a study of fish processing should be to develop an ability to apply fundamental knowledge and adapt existing practices to minimize fish spoilage during the processing and distribution chain between harvest and consumer.

GENERAL ASPECTS APPERTAINING TO COURSE ORGANIZATION

While the most effective way to teach is in a one-to-one situation, it is only in unusual circumstances that this can apply. Training of craftsmen and fishermen has to be part of an overall scheme for a community or group and in such an instance there should be no trouble in producing sufficient students. For a study of rural technology, it is more difficult and, where more advanced technology is required, it is only occasionally that a country can release sufficient individuals on an annual basis to warrant the capital investment necessary to provide suitable facilities. This means that more often than not second or third country training is required where financial aid is required to cover the expense incurred in travelling to a suitable centre. Funding is another matter, however; the resultant multinational group itself creates problems that have already been highlighted in this paper. Unfortunately, there is little acknowledgement on the part of the home country of the aesthetic, cultural and language problems that may face the individual and no allowance for an acclimatization period before the course begins. A frequent problem arises from the fact that the individual is not given a clear picture of the course he is about to embark upon and the objectives of his being sent on such a course.

The actual location of the training establishment is worthy of consideration. For the fisherman, etc., training in skills such as fish preparation or techniques of icing is best carried out at a site adjacent to the work area, e.g., on the beach, in the village or market place; to consider taking such men away from their work environment is to risk divorcing the new idea from the normal situation. Success at this level depends very much on the extension worker having the confidence of the fishermen and being prepared to work for long periods in poor conditions, isolated from colleagues, forgotten by seniors; but all will be to no avail if he does not understand the fundamentals and/or cannot put them over simply. Good examples of what is required are the leaflets 'How to Handle Fish' and 'How to Catch and Keep and Market Ura', issued by the Ministry of Natural Resources, Honiara, Solomon Islands.

It is contended that for the training of fishery officers, etc., a separate purpose-built establishment is desirable, but perhaps the most important point is that it should not be an extension of a research laboratory. Research organizations have an important role to play in the training of individuals or small groups in specialized techniques and acting as advisers to the teaching establishments. In the absence of any other facility, it is better than nothing but one has to admit that research has a higher status and so the research generally takes precedence in terms of availability of equipment, facilities and staff. In such situations, it is not unusual to find staff who are reluctant to teach, have little interest in the success of the course, who neither know of nor care for the relevance of 'their' subject to other sections of the course and are not prepared to spend the time that is necessary to ensure that the individual is practically competent. The problem of status is well demonstrated by this symposium; from the preliminary list of papers it would appear that only two had been submitted on education, training and extension (by authors outside the IPFC Region). Is it implied that training and extension is non-existent in the Region? Is no one proud of what they are doing and achieving in this field? Without this link in the chain, the research and development work taking up over 80 percent of this symposium will be to no avail.

COURSE DURATION

Where fish handling and processing is taught as a background subject, spoilage should be integrated with processing and contain a proportion of practical work and demonstration. As the individual will normally lack technical ability in chemistry and microbiology, practical work would be limited to processing, handling and

sensory assessment. A course of about 50 h duration including at least 20 h practical would seem to be satisfactory if included as part of a broader course. If more than 2 days per week is envisaged on this subject, a longer period of time is required to allow for assimilation between session, perhaps by expanding practical work and introducing suitable visits. Taught by itself, about 3 weeks is suggested, which is a long time for what is purely background study; it is better integrated with another course of direct value to the student.

For the general fishery officer who needs to be able to apply many aspects of fisheries in the field, the following is suggested as the minimum period of study to meet the aims previously identified:

Fish spoilage	50 h (chemistry and microbiology)
Fish handling/processing	150 h (including 60 impractical)

Such a course, plus industrial visits, represents 20 percent of the Diploma in Fisheries Management offered by Grimsby College, U.K., where other subjects studied are: Fish Stocks, Fishing Vessel Design and Power, Fishing Gear Technology, Commercial and Management Principles and Marine Studies, including Oceanography, Navigation and Port Facilities.

As has previously been indicated, the specialist in fish handling and processing requires a good grounding in fish chemistry and microbiology; such a grounding may incidentally form a good foundation for subsequent specialization in either of these areas. The following class contact hours are suggested (taken from the Diploma Course in Fish Handling and Processing offered by Grimsby College, U.K.):

	<i>Theory (h)</i>	<i>Practical (h)</i>
(a) Fish microbiology (assuming no previous experience)	72	144
(b) Fish chemistry, analysis, quality assessment	72	96
(c) Fish handling and processing (all aspects)	144	108
(d) Further experience in:		
(i) recovering and analysing information available in the literature;		
(ii) preparation of a literature review;		
(iii) design and implementation of a programme of practical investigation;		
(iv) reporting and discussion of results		

may be gained by way of a small project, perhaps occupying upward of 200 h of the student's time.

- (e) While techniques of quality assessment are covered under the heading of fish chemistry (including sensory and physical methods), the role, organization and management of the quality assessment function along with the associated statistics and a consideration of international legislation impinging on fishery produce are worthy of particular study especially for the individual employed in an export-oriented situation, 120 h.
- (f) Refrigeration principles are discussed under fish handling and processing; however, a further 120 h would ensure that an individual could prepare data for, and evaluate the practical significance of, quotations for most refrigeration systems and applications; also carry out fault-finding diagnosis and certain corrective procedures (a full-time course in Mechanical Engineering would be required to produce a competent Refrigeration Engineer).
- (g) Packaging, as with refrigeration, would be discussed in the general course, but in certain very limited areas, particularly where exports are involved, more study might be necessary considering the range of specialized testing procedures that may be required with polymer materials.

- (h) To be a fully competent fish quality assessment microbiologist, particularly where a country is exporting to a number of different markets specifying different standards and methods of test, the fish microbiology would have to be extended by at least 100 h.
- (i) Similarly, to be fully competent in fish processing engineering, capable of liaising with mechanical and electrical engineers, at least a further 100 h would be necessary for a numerate individual.
- (j) Management of projects, including management techniques, finance, marketing, economics and human resources might be considered essential study for the general fish handling/processing technologist.

No doubt other subject areas may be introduced. It is suggested, however, that a, b, c and d are essential while the selection of two further units should broaden the general study (e.g., e and j, or f and j) to give specialist study as required. A facility for such combinations helps to ensure an economically viable course which meets most of the requirements for training personnel of management/adviser/instructor level.

It will be realized from this outline that it is suggested:

- (a) The general fishery officer needs a course of study in excess of 200 h if he is going to gain and be able to apply a general knowledge of fish handling and processing;
- (b) The specialist in fish processing cannot be trained in less than a full academic year given a reasonable level of scientific competence in the first place.

RECOMMENDATIONS

The prime consideration of the authors has been to ensure that the student, whether requiring background or detailed knowledge, should have a sound grasp of the fundamentals and a practical ability to apply, adapt, adopt and impart understanding where required.

REFERENCES

- Gauld, J.A., How to handle fish. Honiara, Solomon Islands, Ministry of Natural Resources
1976
- Rogers, J.F., R.C. Cole and J.D. Smith, An illustrated guide to fish preparation. London, Tropical Products
1975 Institute, 73 p.
- Solomon Islands Ministry of Natural Resources, How to catch, Keep and market Ura. Honiara, Solomon Islands,
1977 Ministry of Natural Resources

APPENDIX 1

Basic Facilities for Student Practical Work in Fish Microbiology

Bench area approximately 0.56 m² with gas supply

Bench autoclaves

Incubators 30°/37°/55°C

Stomacher 400

Water baths with control to $\pm 0.25^{\circ}\text{C}$

Microscopes with oil immersion lens

Anaerobic system, e.g., Gas Pak

Stains, media, glassware, etc. (see Micro-organism in food, 1, Thatcher and Clarks, University of Toronto Press, for range of media, chemicals and glassware for quality control analysis)

Method for disposal of infected materials

Large autoclave, preferably with steam boiler

Hot air oven for sterilizing glassware

Facilities for washing glassware

Refrigerator

Area for subculturing, preferably with lamina air-flow cabinet

Balance single pan

Laboratory staff for washing up, preparation of media, disposal of infected material, subculturing, etc.

Overhead projector and screen for laboratory instructions

Hand-washing facilities for students and staff

APPENDIX 2

Laboratory Facilities for First Level of Specialization in Fish Chemistry

Working area, 0.47 m² per student; floor area, 1.87 m² per student

Pipettes, calibrated 0.1, 1.0, 2.0, 5.0, 10.0 cm ³	3 per student
Pipettes, bulb 1.0, 5.0, 10.0 cm ³	3 per student
Pipettes, bulb 2.0, 3.0, 20.0, 25.0 cm ³	1 per student
Pipettes, bulb 50.0, 100.0 cm ³	1 per 10 students
Safety bulbs for pipette operation	2 per student
Conical flasks, 250 cm ³	5 per student
Conical flasks, 100 cm ³	5 per student
Vacuum flasks with sidearm, 250 cm ³	1 per student
Filter funnels, large	3 per student
Filter funnels, small	3 per student
Test tubes, large stoppered	10 per student
Test tubes, small, stoppered	10 per student
Burette, 50.0 cm ³	1 per student
Burette, 5.0 cm ³	1 per student
Conway microdiffusion apparatus	2 per student
Measuring cylinders 10, 25, 50, 100 cm ³	1 per 3 students
Test tube rack (min. 15 tube capacity)	1 per student
Beakers, 50, 100, 250 cm ³	3 per student
Beakers, 400, 600, 800 cm ³	2 per student
Bunsen burner, gauze, tripod	2 per student
Electric heating mantle	1 per 2 students
Kjeldahl digestion flasks	1 per student
Digestion rack for Kjeldahl	1 per 5 students
Distillation equipment for Kjeldahl	1 per 3 students
Glassware with ground glass joints:	
Round bottom flasks, 100, 250 cm ³	1 per 2 students
Air condensers to fit	1 per 2 students
Water condensers to fit	1 per 2 students
Funnels to fit	1 per 2 students
Splash-heads to fit	1 per 2 students
Delivery tubes to fit	1 per 2 students
Soxhlet extraction units	1 per 2 students
Homogenizer	1 per 2 students

Mincer	1 per 5 students
Chopping boards, filleting knives	1 per student
Swing head centrifuge	1 per 10 students
12 x 100 cm ³ tubes and lids	1 set per 10 students
pH meter and electrodes	1 per 10 students
Refractometer	1 per 10 students
Colorimeter and/or spectrophotometer	1 per 10 students
Volumetric flasks, 25.0, 50.0, 100.0 cm ³	2 per student
Volumetric flasks, 250.0, 500.0 cm ³	1 per student
Hot Air oven	1 per 10 students
Vacuum oven	1 per 10 students
Moisture dishes with lids	4 per student
Muffle furnace	1 per 10 students
Crucibles and lids	1 per student
Fireclay triangles	1 per student
Lazy tongs	1 per 10 students
Water bath, thermostatically controlled	1 per 10 students
Incubator	1 per 10 students
Balances, top loading 0-1 kg	1 per 3 students
Balance, accurate to 1 mg or better	1 per 3 students
Miscellaneous:	
Rubber tubing, glass tubing	
Filter papers, various sizes and grades	
pH indicator papers, litmus indicator papers	
Soxhlet thimbles	
Ground glass adaptors, stoppers, etc.	
Services: minimum 1 technician-hour per 5 student-practical-hours, 1 cleaner and access to instrument mechanic electrician	
Hot and cold water	
Vacuum	
Single phase electricity	
Gas	
Sample storage space, 0.34 m ³ per 10 students	
Refrigerated storage, 0.17 m ³ per 10 students	

Frozen storage for raw materials, 1.42 m^3 per 10 students

Reagent and equipment preparation area, 14.9 m^2 ; floor area with storage space for equipment, glassware, reagents (acidic, flammable, etc.) tools, spares

Equipment washing facilities

Equipment drying facilities

Ice-making equipment

Spark-proofed fume cupboard per 5 students

Disposal service for waste (toxic, flammable chemicals, etc.)

Reference texts:

Log and statistical tables

Food Industries Manual

Chemical Rubber Company Data Book

Fire extinguishers	)
Fire blankets	) often covered
Eye-bath and first-aid cabinet	) by legislation

Soap, towels, drying cloths, mops, brushes, etc.

APPENDIX 3

The following table lists:

- (a) possible areas of study in the processing and handling aspects of a course;
- (b) an indication of the fundamentals considered essential study for all first line management;
- (c) possible associated areas of study that may be necessary for the specialist in fish handling and processing.

A knowledge of the causes and mechanisms of spoilage is assumed.

Areas of study	Fundamentals	Associated areas of study
Filleting, gutting, skinning, descaling Icing/distribution of iced fish))))) Refrigerated sea water/) chilled sea water) Ice manufacture Cold storage/ distribution of frozen food Dehydration Curing Smoking	General hygiene Heat capacitance; heat transfer; insulation properties of air, comparative conductivity of metals, fluids, fish, gases Heat transfer, introduction to refrigeration systems, ice crystal development Vapour pressure/temperature relationships, water migration in frozen foods, heat loads in cold store Concept of water activity and its relationship to vapour pressure, bulk density concept, definition of wet and dry bulb temperatures	Design of mechanical methods Surface heat transfer coefficients. Thermal conductivity through composite materials Problems associated with calculation of freezing times, calculation of freezing rates, estimation of surface heat transfer coefficients Design aspects of freezers, cold stores, refrigerated transport Drying rate of calculations. Humidity charts and tables. Air flow characteristics in dryers and kilns

Marinating	Preservation index, differentiation between weak and strong acids. Temperature control	Flavour development
Fermentation	Differentiate between microbiological and chemical changes	
Comminuted products		Size reduction, stabilizers, emulsifiers, bleaching
Canning	Logarithmic relationships, can seam integrity, chlorination of cooling water	Estimation of effective process time
Water treatment	Chlorination of cooling water	Filtration, centrifugation, fermentation
Hygienic design of plant and buildings)	Surfactant theory	
Sanitation and cleaning)		
Irradiation		
Fish meal manufacture)	Nutrition	Evaporation, extraction, separation
Fish silage)		Enzymic digestion, acid preservation
Fish protein concentrate)		Extraction, separation, modification
Packaging	Principles of asepsis	Properties of packaging materials

PROBLEMS AND PRACTICES IN FISHERIES TRAINING AND EXTENSION: AN AUSTRALIAN VIEW

by

H.E. Rogers
Department of Primary Industry
Canberra, Australia

Abstract

The paper deals primarily with on-the-job training and extension services for the fishing industry in Australia. Training activities such as those conducted by technical and maritime colleges are not discussed. Methods of investigating the training and extension needs of the fishing industry are examined and steps by which these needs may be satisfied are suggested.

The paper divides training and extension programmes for the fishing industry into four stages. The first of these deals with identification of the training and extension needs of the industry. During the second stage, a programme is designed to meet these needs. Implementation of the programme constitutes the third stage and evaluation of results forms the fourth. The relative merits of the methods used during each stage are discussed and suggestions are made concerning which methods are to be preferred.

INTRODUCTION

Training and extension for persons engaged in the Australian fishing industry are very much in their infancy, but recent events have highlighted the need for greater attention to be paid to these activities.

The federal system of Government and the consequent government involvement in the administration of the fishing industry present problems when considering a uniform national approach to training and extension, particularly when both activities are essentially state responsibilities. Rather than enter into the argument of how training and extension can best be coordinated and implemented under our system of government, I shall confine myself to the generalities of identifying training and extension needs, and providing guidelines for the conduct of programmes to satisfy these training and extension needs.

Training and extension are closely related and providing definitions which are generally acceptable can present problems. As this paper will concern itself solely with the less formalized or field exercises rather than college or school-based activities, I shall describe my terms accordingly, *viz.*:

Training may be considered an on-the-job type activity which is primarily concerned with teaching skills and which will lead to improved safety and/or efficiency;

Extension may be considered as two-way communications using whatever means are deemed necessary to convey information with the objective of improving the level of understanding and changing attitudes.

IDENTIFICATION OF NEEDS

Let us assume that we are aware of programmes conducted by educational institutions and that we are also aware that other government authorities and some industry organizations are engaged in *ad hoc* programmes. Initially, or in conjunction with the investigation method, all programmes available should be indexed and it should be ensured that the index is current when the investigation is completed.

The method of determining the needs of the industry must be investigated on a systematic basis taking each step to its conclusion. A suggested method follows:

Industry interviews

Interviews should be conducted with management and operatives, on a selective basis. In Australia, probably the most effective approach would be, first, to define the fisheries and their structures and then select individuals rather than groups; otherwise the majority faction or senior group is likely to dominate the discussion.

Questionnaires are not considered to be an effective alternative to interviews as they presuppose that the questions that should be asked are known when, in fact, experience has shown that often irrelevant questions are included, emphasis on some questions is often misplaced and many questions of significance are omitted. This impersonal approach leaves the onus on the recipient to complete the questionnaire accurately and conscientiously without the personal influence that there would otherwise be in a direct interview; the latter having the advantage of drawing the interviewee out as much as possible, thus gaining the full benefit of his knowledge and experience. Having discredited questionnaires as an alternative, that is not to say that they cannot prove a useful aid when interviewing and a questionnaire may be developed as the knowledge of the industry develops.

Industry attitudes

In order to complete the picture and develop proposals which are likely to be acceptable, it is necessary to evaluate the attitudes of industry toward research, management, regulation intervention and, obviously, training and extension. This exercise should be conducted in conjunction with interviews; however, the evaluation proper will be consolidated when all information is at hand. This exercise presupposes that management has a positive attitude and is likely to support the general principles involved in the final analysis. If those responsible for the exercise are not sure of management's attitude, then it may be necessary to conduct similar interviews with management in order to clarify the situation.

Governmental advice

As there are a number of government authorities which have some involvement in various aspects of the industry, it is necessary to obtain data and advice from these authorities as there are great dangers in dealing with any problem in isolation and not understanding the full ramification of any corrective strategy that may be used.

History

In order to avoid the pitfalls of the past, it is desirable to review past attempts at improving the fishing industry and training and extension in Australia. Although our experience is limited in both of these fields, there is no doubt that there is much to be learned from projects which have been undertaken to date.

Comparative programmes

There are a number of primary industries which are, to varying degrees, serviced by training and extension programmes. A comparative review of these programmes may well prove invaluable in developing guidelines for the fishing industry.

Overseas activities

Similarly, a review of overseas training and extension programmes, particularly those relating to the fishing industry, will provide an invaluable contribution to the development of programme guidelines.

PROGRAMME METHOD

When all the ingredients for a programme have been collated, thought should be given to the development of a model for testing in a pilot or experimental situation. There are various forms that the model may take depending on the industry group concerned and it would be unwise to illustrate specific examples which might be quite inappropriate to follow.

The purists would abhor the thought of proceeding to the stage of providing programme guidelines without, first, stating objectives. In order that I do not upset the *status quo*, I shall be mindful of the broad objectives inherent within the descriptions of terms. I say this because we cannot enforce programmes nor are we dealing with a captive audience.

Fishermen are a unique body to deal with because if fishing is good, a visit to a port may prove to be an exhilarating experience but little, if anything, will be communicated or learnt.

Having identified needs, the proposed programme must be publicized as much as possible. This is easier said than done; our experience has been that fishermen are not readily receptive to written communication and the only guarantee of information being received is to transmit it by word of mouth and have it acknowledged.

Even in the off-season, time is still money and programmes must be of short duration and, if travel is involved, it may be worthwhile conducting a number of programmes concurrently. As far as courses are concerned, they must be practically oriented and theory should be limited to that which is necessary to maintain and efficiently operate a machine, item of equipment or a system. It is not enough for the people conducting programmes to be fully conversant with the subject matter involved; they must be able to communicate at the appropriate level and display the qualities commensurate with good teaching and reporting practices.

CONCLUSION

I have endeavoured to present a number of thoughts which may have some application to other countries but are considered to be, perhaps, most relevant to the Australian situation. I have not given any specific examples of programmes which have been or are currently being undertaken in Australia as this would require great detail with little in the way of originality to impart.

There is no doubt that training and extension provide important links between management and industry and are the most effective methods of ensuring that industry is made aware that management is concerned with its welfare.

In a large country like Australia with a coastline of some 12 000 mi, it presents a considerable task in terms of time and resources to meet the training and extension needs of the fishing industry. There is, however, a positive attitude toward satisfying these needs and doubtless the techniques and expertise will grow in time.

FISHERIES EXTENSION IN RURAL DEVELOPMENT PROBLEMS AND PROSPECTS

by

R.C. Cole
Tropical Products Institute
London, U.K.

Abstract

The role of extension services is reviewed together with comments on the different patterns of operation in the IPFC region. In many countries the fisheries extension function is relatively new but there is an increasing awareness of its value. Some of the problems involved in making extension services more effective are considered and means of bridging the gap between the fishermen and the administrator or research worker are discussed.

INTRODUCTION

The fisheries of almost all the countries of the IPFC region are underdeveloped in one sense or another and we all know that the development of a fishery requires two prime inputs: the injection of capital and the education and training of people. Provision of capital alone is almost always useless but some forms of training cost little in themselves and reduce the amount of money which would otherwise be needed. Teaching the users to maintain equipment properly so that its useful life is extended is an obvious example.

Fisheries education and training may take many forms. The various ways in which training could be provided for the many different specializations needed in a fishing industry are discussed by Cole and Hall (1973). Broadly speaking, educational methods take two forms; formal instruction in a teaching institution and the less formal, but vitally important, learning patterns which can be provided by an extension service. The extension services are so important because there is no other way to reach the millions of people who work in the artisanal or small-scale fisheries. To those who say that the modernization of their fishing industries will sweep away the small-scale fisheries, one can only suggest a look at Japan, North America and Europe. In all these areas small-scale fisheries flourish alongside fisheries using large, sophisticated, modern vessels. There is no reason to suppose that the small-scale fisheries of the IPFC region will quickly disappear; on the contrary, there are strong reasons for supporting and improving these. Some of the more obvious and important reasons are suggested by Cole (1973).

Although the living conditions of those who work in the small-scale fisheries have improved dramatically in some countries in the last decade, in other places conditions are still extremely uncomfortable and often squalid. Housing may be ramshackle and crowded; sanitary facilities are absent, or at best, primitive; water is drawn from shallow wells, with the consequent risk of disease, and light is provided by oil lamps. Debilitating diseases are endemic; there is little or no medical, dental or pre-natal care and education is poor, even at the primary level. The communities are isolated and communications difficult. Shopping for anything other than the most immediate necessities of life is difficult and even these are much more expensive than in the towns. Catches fetch low prices because the risks in attempting to market wet fish are so high. Crude processing methods result in low-grade products of poor keeping quality. Processing thus prevents total loss but reduces rather than adds value.

Such benefits of modern civilization as have arrived have often proved to be mixed blessings. The outboard motor, designed and built for occasional use in sport fisheries, is generally a poor tool for the day-in-day-out slog of small-scale commercial fishing. It is by no means always certain that nets made with synthetic materials result in an increase in catch which can be maintained from year to year. Both synthetic materials and fuel are now very expensive; we may yet see a partial return to sail. Under such conditions advice and help are needed to solve both technological and socio-economic problems. Many of the problems could be solved by the proper application of existing knowledge. In other cases, both experiments and careful costing of the experiments are needed before advice should be given. This is the origin of the term "extension service", coined at Cambridge University in the last century to describe the group of people needed to extend the results of agricultural research to farmers. The importance of careful costing cannot be emphasized too strongly; experiments should be carried out by officials or academics, not by poverty-stricken fishermen or fish processors. Only technological innovations of proven profitability should be advocated by the extension services. Cole (1977) and James (1977) elaborate on this point. It is difficult for extension workers to gain the confidence of the artisanal fishermen and it would be altogether too easy to throw away the advantage gained by suggesting an innovation which loses money. So far the term "extension service" has been used undefined, with no clear indication of the way in which such a service should be formed or administered, or how it should operate. A brief indication must be attempted.

THE FISHERIES EXTENSION SERVICE

Many senior officials are not sure what an extension service is or what it should do. Yasueda (1972) explains the operation of the Japanese fisheries extension service and MacDonald (1975) discusses some of the needs of the artisanal fisheries of the developing world. In general terms, the function of a fisheries extension services is to spread knowledge and techniques among fishermen and other operatives in the fishing industries so as to modernize the management of fishing enterprises thus improving productivity and raising living standards.

It is generally agreed by those who have done extension work among artisanal fishermen that a body of men and women, about one worker for each 500 fishing families, should be trained as generalist technologists. There would be obvious advantages in training people to a higher degree of specialization but, for most countries in the region, this would be too expensive. There must be some specialists, perhaps one for every ten generalists and one line supervisor for every four or five field workers. Training time is usually two years, assuming an intake of people who have had 12-13 years' schooling. The trained worker is expected to live in close touch with the people he serves. Since this involves a considerable degree of hardship, there should be compensatory advantages in terms of salary, allowances, leave, etc. There should be adequate opportunities for advancement within or outside the extension service. Since extension work should be a full-time occupation and since it is of prime importance to gain the confidence of the operatives within the industry, the extension worker should ideally have no licensing, regulatory or other statutory functions such as the collection of statistics. The field extension worker must have adequate administrative and technical backing. His work plans must be discussed and approved by senior officers who can provide technical advice and arrange for the provision of necessary funding. Above all he must be the link between the workaday level of the industry and officialdom. He will often come across questions which he cannot answer. If no one else in the country knows the answer, there must be arrangements to seek advice elsewhere. Sometimes there will be no ready-made answer so there must be arrangements for research or experimentation. In any case, the answer should pass back through the field worker. This all requires that the service should have adequate links with other branches of the fisheries administration, especially the training institutions, with the universities, with other government departments and with commerce.

There are a large number of different ways in which an extension worker can go about the task of familiarizing himself with the needs of the industry and meeting those needs. He should make frequent and informal personal contacts with individual fishermen or groups of fishermen, he should visit the places where they work and hold pre-arranged formal meetings with groups of people. He should carry out demonstrations, and

arrange study tours of other areas and visits by specialists. Cole (1976), in outlining some possible means of providing training, goes into some detail of the ways in which an extension service should operate. Extension work started in agriculture and many publications written primarily for agriculturists provide useful suggestions for techniques and operational methods, notably Bradfield (1966) and Maunder (1972). Chambers (1974) offers some interesting thoughts on the wider implications and problems in rural development. All this sounds facile; provide funds, train some field workers and, hey presto, we have an extension service. But few countries have a fisheries extension service that truly provides for the needs of their fishing industry. So things go wrong; I can suggest some possible reasons, no doubt others would suggest a completely different but equally valid set.

THE EXTENSION SERVICE IN REALITY

It is a truism that theory does not always work out in practice and there are few good fishery extension services anywhere in the developing world, or elsewhere for that matter. Even the most advanced fishery could use a good extension service to bring it advice and place its problems with those most likely to solve them. Some questions are posed and some suggestions for the possible causes of failure are offered in the hope that these will stimulate discussion and possibly lead to some better solutions.

Concept

Perhaps the whole concept is wrong? Maybe it is no good expecting a small number of generalists to identify the problem areas. Yasueda (1972) suggests that this method works well in Japan; it certainly works well in agriculture, in the livestock-raising sector as well as in others. Would it be better to use a mobile task force approach and to saturate an area with experts for a short time rather than relying on longer term, more intimate acquaintance to bring out and resolve difficulties? Most of us have seen something like this tried (in the very short term) by way of a ministerial or similar visit. The result usually seems to be that the hoary old insoluble problems are dusted off and aired yet again. There seems to be no substitute for the long appraisal; this might be better made by an experienced senior officer rather than the comparatively junior man, who is the typical extension worker. Such people are scarce and expensive; many of them would think the duties of an extension worker beneath their dignity. The field workers' immediate superiors should of course be more experienced officers and they should take every opportunity to visit the field workers' areas with them.

Perhaps the best concept is still that of the extension work undertaken by the universities. The problem here would seem to be that in developing countries very few academic people have, or are willing to acquire, the intimate knowledge of the way of life in the rural areas which is needed for successful extension work.

Organization

Is one of the main reasons for failure poor organization? Are the field workers wrongly placed, ill trained and undersupervised? Are there too few people in the field and too many in headquarters? Have any of the people in headquarters had any practical experience in the field? Is the extension service perhaps regarded as of little importance so that the best staff are never attached to it? Do the officials have other duties which prevent their devoting sufficient time to the extension service? Some duties, such as licensing, statistics collection and regulatory functions have statutory time limitations and preoccupation with these would be understandable.

Is proper use being made of the expertise available in academic institutions? It is not unusual to find academics working on research problems which appear to have little, if any, relevance to the needs of the industry. Is this just lack of communication or are the problems of industry too difficult for the universities or of little interest to them?

Staffing and service conditions

Are the right people being chosen for extension work? Perhaps there is little question of choice, some services may have to take whoever they can get. The best qualified people might well prefer to work in the cities where life is brighter and promotion prospects better than in the field. If this is even part of the problem what can be done about it? Conditions of service are often somewhat rigid and it may be difficult to reward devoted service adequately. Perhaps everyone who has any aspirations to rise in the fisheries service should be expected to spend a reasonable number of years working in the extension service?

Are field staff always given adequate training? Not just in the technologies; training in extension methods is also needed. This is often available within the ministry responsible for agriculture but fisheries people do not always know that this is so. Or does professional jealousy prevent them using the facilities of another department?

CONCLUSION

Whatever the answer to these problems and the others which we know exist may be, there is no doubt that we should continue to seek solutions because those of us who have seen an efficient extension service at work know how useful this can be in promoting the development of a fishery.

REFERENCES

- Bradfield, D.J., Guide to extension training. Rome, FAO, 169 p.
1966
- Chambers, R., Managing rural development. Uppsala, Scandinavian Institute of Management, 215 p.
1974
- Cole, R.C., Fisheries development and requirements of fisheries education and training in Malaysia, Thailand, Fiji 1973 and The Philippines with particular reference to the artisanal sector. *FAO Fish. Rep.*, (143):55 p.
1976
- Fishery training needs in the Western Central Atlantic. *WECAF Rep.*, (1):71 p.
1977
- Fisheries extension services; their role in rural development. *Mar. Policy*, 1(2):132-42
1977
- Cole, R.C. and D.N.F. Hall, Guide to education and training. *FAO Fish. Tech. Pap.*, (128):343 p.
1973
- James, D.G., Fish processing and marketing in the tropics: restrictions to development. In Proceedings of the 1977 Conference on the handling, processing and marketing of tropical fish. London, Tropical Products Institute, pp. 299-302
- MacDonald, A.H., Extension methods and co-operative development of artisanal fisheries. Zambia, 34 p. (mimeo)
1975
- Maunder, A.H. Agricultural extension: a reference manual, Rome, FAO, 270 p.
1972
- Yasueda, T., Fisheries extension service. Rome, FAO, FIE:FET/77/Bp3:20 p.
1972

EDUCATION AND TRAINING FOR DEVELOPING COUNTRIES: ACTIVITIES IN IUFOST

by

J.F. Kefford
CSIRO Division of Food Research
North Ryde, N.S.W., Australia

Abstract

The Committee on Education and Training of the International Union of Food Science and Technology (IUFOST) has been active in several areas relevant to developing countries although they relate to food technology in general and not specifically to fish technology.

In particular the following activities will be reviewed:

- (a) Directory of Courses and Professional Organizations in Food Science and Technology;
- (b) The role of the professional organization;
- (c) The relevance of Ph.D. programmes to the needs of developing countries;
- (d) Training for research management;
- (e) How to meet the need for technical officers.

INTRODUCTION

I am very pleased to have the opportunity of contributing to this symposium and I regret that I am unable to present this paper in person. I am presuming to present the thoughts which follow on the basis of my experience in two areas. Firstly, as an officer of the Commonwealth Scientific and Industrial Research Organization (CSIRO) Division of Food Research which has, in the last 30 years, accepted for training and research experience some 130 persons from developing countries, mainly from the Indo-Pacific region, and secondly, as Chairman of the Committee on Education and Training of the International Union of Food Science and Technology (IUFOST). I wish to make it clear, however, that my views are personal ones and are not necessarily the official views or policies of either CSIRO or IUFOST.

I would like to tell you first about some of the activities of the IUFOST Education and Training Committee. By force of circumstances this Committee must work mainly by correspondence and, accordingly, it has appointed Correspondents in the 37 member countries of IUFOST. It follows that its activities must be those that can be undertaken by correspondence.

DIRECTORY OF COURSES

The first activity of the IUFOST Education Committee was to prepare a Directory of Courses and Professional Organizations in Food Science and Technology which was published in 1973 and contains information from 26 countries. Copies of this Directory are still available but it is hoped that an updated edition will be published in time for the Fifth International Congress of Food Science and Technology in Kyoto in September 1978.

In relation to the present symposium it is important to explain that the Directory covers courses in food science and technology in general, and not specifically courses in fisheries technology, although fisheries technology will be a component subject in many of the courses listed. Education in fisheries technology presents particular problems because it is an interface area, the interface between the technology of capturing the raw material and the technology of conserving the product. The food science and technology of agricultural products is often said to commence "at the farm gate" but in practice it is seldom possible to draw a line at this point. It is even more difficult to draw a line in fisheries technology at the point "where the fish leaves the water". The same persons must very often be involved with the technology on both sides of this line and therefore there is a need for broad training programmes. At the same time there is also a need for specialists whose areas of expertise are well defined on one side of the line or the other.

PROFESSIONAL ORGANIZATIONS

The IUFoST Directory also includes, for each country, information about the professional organization, where it exists, in food science and technology. It was hoped that the requirements for professional status in each country would provide a basis for comparison of the standard of courses from country to country but, in fact, there are great difficulties in comparing educational systems and academic titles between countries. However, I believe it is relevant in this symposium to stress the important role of the professional organization in contributing to the technical welfare of any industry, for the following reasons:

- (1) The professional organization is the guardian of standards of professional training and can give useful advice to educational institutions about the standards of their courses and their relevance to the needs of the industry.
- (2) The professional organization may often take the initiative in the educational role and organize, in cooperation with other bodies, short courses and training programmes in specific areas of need.
- (3) The professional organization is a meeting ground for people from the three areas, industry, government and education; this is a very important role. In all countries, and particularly in developing countries, good communication between these three sectors is essential for the technical welfare of industry. Experience suggests that in developing countries, the government man is often regarded with suspicion and reserve and this attitude can best be broken down on a personal basis as a result of mutual confidence established in the gatherings of a professional organization.

There may be a dilemma here for fisheries technologists as to whether to form professional organizations in their own field or whether to link up with professional organizations in food technology, in which, of course, there may be fisheries technology groups. There are good arguments in favour of each course of action.

PH.D. PROGRAMMES

IUFoST also has a Committee on the Needs of Developing Countries and, in 1975, that Committee requested the IUFoST Committee on Education to "examine how higher degrees (Ph.D.) may be more closely related to the needs of developing countries", and stated further in explanation that "developing countries do not want second-rate scientists but the present curricula for higher degrees (Ph.D.) as offered in developed countries may have little or no relevance to the attitude of mind and the work needed in developing countries. Consideration should be given as to whether a different type of higher degree training is now desirable for applied research workers, those whose responsibility it is to serve small food processing and distributing industries".

The IUFOST Education Committee has so far tackled this problem by inviting views from its Correspondents in different countries. The replies have revealed a wide spectrum of views on the problem. The most extreme view is expressed in the words of a professor of food science from Europe: "When you are speaking of a Ph.D. degree, you refer to writing a doctoral dissertation. This is always based on high level experimental work, in general of more fundamental nature, and I do not see a relation between this type of work and problems of developing countries". This is the conservative or traditional view which sees the Ph.D. as a research degree which indicates a man's scientific stature and considers that the subject of the research for which it is awarded is largely irrelevant. It is argued that a man who has been awarded the Ph.D. for his ability in research should be able to turn his hand to the solution of a wide range of problems. In practice, however, it is often very difficult to persuade a Ph.D. to move out of his specialized area for a number of reasons: he is likely to develop a genuine interest in the field; he may lack confidence in research outside this field; and he knows he is likely to achieve results, publications and advancements more quickly if he remains in that field. Often, however, in developing countries, this leads to the sad situation where a Ph.D. trained in the use of specialized equipment no longer has access to this equipment and his research effort flounders.

Another concept underlying the conservative or traditional view of the Ph.D. is the expectation that the degree has universal meaning, i.e., that whatever the university the award represents comparable competence in research. This may be a pious hope but nevertheless it is true that many universities endeavour to unify their standards by making use of external referees for Ph.D. theses.

Fortunately there are many universities around the world which are mindful of these aspects but consider that it is possible to maintain the standard of the Ph.D. degree and still provide the candidate with a research project relevant to his country's needs.

Different universities have tackled this problem in different ways. From one university which has handled a significant number of Ph.D. candidates from developing countries, our correspondent writes as follows: "Our aim is always to try to recognize an applied problem for overseas students relevant to their country's needs. Our intention is that the candidate should solve this problem in a manner that could lead to its industrial exploitation and, at the same time, the study should be developed in depth in at least one disciplinary area, e.g., chemistry, microbiology, engineering, etc. I believe we have achieved our objectives with all candidates so far, in that they have developed real interests in the technological exploitation of knowledge".

In other countries the need has been met by a cooperative arrangement between two universities. A university in a developed country agrees that a Ph.D. candidate should do all or part of the field work for the degree in his own university in the developing country. The candidate has a supervisor in each university and he spends approximately equal periods working in each university. For the arrangement to work well, there must be close links between the university departments involved and mutual knowledge of resources and needs.

Clearly, many variations are possible in the way programmes are handled while still maintaining both academic standards and relevance. It is most important that Ph.D. candidates from developing countries should receive proper guidance, e.g., from funding bodies, as to the universities that are most likely to meet their specific needs for training.

It is well known that the situation with regard to Ph.D. degrees is complicated by questions of status and prestige. Students sent overseas for training are considered to have failed or lost face if they return without a Ph.D. or even a Master's degree, which in many cases would be more relevant. The Ph.D. may be all-important in determining selection for a position. On the other hand, those who return with a Ph.D. expect to be accorded a status which precludes the down-to-earth tasks that are needed to solve their country's problems. These are hard words, and there are many individual exceptions, but I believe they need to be said.

Against all that I have said about the Ph. D. degree must be placed the fact that the value of the Ph.D. has been debased because of oversupply. Throughout the developed countries for several years there has been a glut of Ph.D.s in science and they have had difficulty obtaining positions commensurate with their qualifications. In CSIRO we have many Ph.D.s quite capable of being Research Scientists who have accepted positions at the Experimental Officer level. In contrast to this problem of oversupply I believe that there is a real problem of undersupply of supporting staff and I return to this matter in a later section.

TRAINING FOR RESEARCH MANAGEMENT

The IUFOST Committee on the Needs of Developing Countries has recently asked its Education Committee to consider yet another question: what kind of training might be recommended for scientist, proceeding to the management of research institutions in developing countries? A young scientist, well-qualified in his special field, a Ph.D. no doubt, may be "pitchforked" into the directorship of a research laboratory without any knowledge or experience of the management of people or funds. There are many who believe that research directors, and indeed good managers, are born and not made but, nevertheless, in developed countries many university courses and short-term training programmes in management are offered. Our Education Committee is asked to examine such courses and to recommend appropriate training programmes for research management in developing countries.

CSIRO has been sensitive to the need to provide management training for scientists in supervisory roles and has held a series of one-week intensive training programmes where a group meets in an isolated centre under the supervision of a university psychologist.

NEED FOR TECHNICAL STAFF

Until now I have been talking about education and training to professional levels, i.e., to what is often referred to as higher level or tertiary training. I am sure few would dispute that there is a very great need, if not an even greater need, for training at lower levels. It is customary to use this term "lower levels" of training but they are certainly not lower in importance or priority.

It is the training of people who provide the support staff for the professional man and without whom the professional man cannot work effectively. These people in CSIRO are called Technical Officers, elsewhere they may be called Technicians, and they may overlap into the category of Technologists. They are necessary and ubiquitous people in industry and research organizations in the developed countries but my impression is that they are thin on the ground in developing countries. The ratio of professionals to supporting staff in research laboratories in developing countries appears to be favourable, e.g., 1:4, but the supporting staff is often insufficiently trained to be truly useful. The people I am talking about need real skills in various laboratory or industrial arts; these they can acquire only by the right mixture of formal training and experience. In developing countries they are likely to find many roles: as technical assistants in laboratories; as technical assistants in industry; as technical service men for food and laboratory equipment and instruments; and as extension officers demonstrating good practices to village-level industries. These are the people who are not afraid to get their hands dirty in the course of solving a problem or getting a job done.

It is my firm belief that the training of technical staff can be satisfactorily undertaken only in their own countries. In CSIRO we have seen the need for trained people at this level and we have asked ourselves whether it is our business to provide such training. But I believe that it is not our business, nor that of other bodies in developed countries, for at least two reasons. First, there are real sociological problems in bringing to a foreign country the type of student interest in this level of training, as compared with the university graduate interested

in post-graduate training. The student interested in technical training is less likely to have a command of a foreign language and, by his whole intellectual and social background, is less likely to settle comfortably in a foreign country. The converse is also true; if you take a more highly educated person and send him for technical training overseas he is likely to be unhappy and to wish for academic training so as to have a higher status when he returns.

The second reason why the technical person is better trained in his own country is that his formal instruction should be closely related to the industry and problems in his own country so that he has an immediate appreciation of the relevance of the content of his course. Moreover, there is a real danger that training in a developed country may mean training in the wrong technology. There have been many examples of the folly of the transfer of highly mechanized technology from developed countries to developing countries where a labour-intensive technology is necessary for economic and social reasons.

In relation to the present symposium, the seafood industries in the Indo-Pacific region include many traditional procedures which have evolved, perhaps over centuries, as successful ways of preserving perishable foods by simple means, e.g., the shrimp paste (belacan) and fish sauce (budu) industries of Malaysia. It is patently impossible to undertake any radical technical development of these industries in the short term. Nevertheless their standards of hygiene and quality could be steadily upgraded by the correct guidance from technical people trained in close contact with the local environment.

What all this means in practice is that the technical education systems in developing countries should be strengthened; they should be encouraged to provide courses in the area of food technology and, where appropriate, specifically in fisheries technology. Such programmes do exist, for instance, in the MARA programmes in Malaysia, and I am sure that there are analogous programmes in other countries of the Indo-Pacific region.

Having said that, I realize that it is perhaps just shifting the problem one step because these courses must be staffed with people who are themselves trained and experienced in the technologies concerned. Visiting teachers from developed countries may perform these functions in the short term but, in the long term, there must be permanent staff who may well have received post-graduate training in developed countries. It follows that teaching positions in technical education should be given rewards and status sufficient to attract well-trained people.

In conclusion, I am very conscious that I have aired problems rather than present solutions, but I hope that this may stimulate profitable discussion. I would like to affirm the interest of the IUFOST Committee on Education and Training in your deliberations and to offer our assistance in implementing any recommendations that may come out of this symposium.

B.S. MAJOR IN FISH PROCESSING TECHNOLOGY
AT THE UNIVERSITY OF THE PHILIPPINES

by

P.T. Arroyo, L.M. Santos and L.S. Mendoza
Department of Fisheries Technology
University of the Philippines
Diliman, Quezon City
The Philippines

Abstract

A B.S. major in fish processing technology as well as a diploma in fisheries and a major in fish preservation are being offered at the University of the Philippines, College of Fisheries' Department of Fisheries Technology. Prospects and problems of placing graduates in industry are discussed. At the leading centre of training on fisheries technology in The Philippines, the Department has noted a steadily increasing enrolment. The curriculum is discussed in relation to the Department's effort to apply technology to the fishing industry, extension service and training.

INTRODUCTION

The College of Fisheries of the University of the Philippines (UP) started in 1958 from the now defunct Philippine Institute of Fisheries Technology (PIFT), then part of the Bureau of Fisheries. The Department of Fish Processing Technology is one of three academic departments of the UP College of Fisheries; the other two are the departments of Marine Fisheries and of Inland Fisheries which offer B.S. programmes in Marine and Inland Fisheries, respectively. The objectives of the Fish Processing Technology Department are:

1. To provide undergraduate education in the field of fish processing technology, taking into account the needs of the country for qualified manpower in industry, education, research and extension services.
2. To undertake basic and development-oriented research programmes toward:
 - (a) the maximum utilization of aquatic resources to improve the nutritional status and general welfare of Filipinos;
 - (b) the standardization and improvement of existing products and processes in the utilization of aquatic resources.
3. To set up raw material requirements for aquatic products with maximum market potential to serve as guidelines in fish production.
4. To render extension services to government, private and other agencies in all aspects of fish processing and link its research programmes with national government extension efforts.

DEPARTMENT OF FISH PROCESSING TECHNOLOGY

Academic programmes

The Department offers a programme leading to the B.S. degree in Fisheries, with a major in Fish Processing Technology. The student is trained in all aspects of processing from fish handling to the finished product including inspection and quality control. Courses in aquatic flora and fauna, microbiology and general chemistry precede processing subjects which involve dehydration, low temperature preservation and thermal sterilization, approached both from the traditional and modern aspects. Processing subjects are intermingled with more advanced courses such as biochemistry; chemical techniques of analysis and quality control. A course on fish plant management is taken after completing most of the processing subjects. Finally, the student works on a research problem involving a specific area of fish processing technology.

Areas the students have worked on include proximate analyses of fresh and processed products, post-harvest handling of fish, fish protein concentrate manufacture, evaluation and utilization, development of fishery products (such as fish sausage, hydrolysates) as well as utilization of minor fishery products and by-products such as seaweeds, fish scales, etc. Field trips to processing establishments and government agencies engaged in related work supplement the training in the laboratory. Undergraduate theses cover a wide range of subjects and the data accumulated may not always be published through lack of funds, lack of time before graduation, etc. However, there is valuable information among these works.

Interspersed with the specialized training on fisheries the student also takes up general education courses in languages and social, political and natural sciences with emphasis on the biological sciences. The general education courses, which account for about 40 percent of the total unit requirements, are in line with the University policy of providing every student with a well-rounded education in the sciences and the arts. A one-month on-the-job-training (Practicum), preferably in the industry, is required of the student for graduation. This serves to give him actual experience in industry and provides a chance to acquaint himself with the processes as they are applied on commercial and semi-commercial levels.

In addition, the department also offers a three-year course called Diploma in Fisheries with a major in Fish Preservation. Appendixes 1 and 2 show the curricula for the programmes.

This is the only department in the state university which offers a B.S. course dealing with processing and quality control of fish and fishery products; the other academic institutions in the country which offer the same B.S. degree are Bicol University and the Mindanao State University. However, this department has the highest percentage of faculty and academic staff who are specially trained in this discipline as shown in Appendix 3. Group Research conducted by the faculty includes studies on fish protein concentrate (Orejana and Juliano, 1975), utilization of milkfish by-products (Santos *et al.*, 1977) and rice-shrimp fermentation (Arroyo *et al.*, 1977). However, this research is still on a limited scale.

It might be of interest to note that the department was called the Department of Fisheries Technology until 26 January 1978, when the University Board of Regents approved the request for a change of name. The rationale for the request is that the name "Fisheries Technology" is often taken to include all technological aspects of fisheries such as fishpond construction, fishing gear, etc. On the other hand, the curricula offered by this Department involve mainly B.S. and Diploma courses in Fish Processing and Quality Control of Fish and Fishery Products as shown in Appendixes 1 and 2.

Profile of students

The enrolment summary of the college for the current semester is given in Appendix 4. Twenty-three percent of the total College enrolment is handled by the Department, Marine Fisheries handles 16 percent and Inland Fisheries, 60 percent. Students enrolled in the B.S. in Fisheries major in Fisheries Business Management

are not with any specific department, the programme having been instituted only recently in collaboration with the College of Business Administration, also of UP students in the said programme constitute 1.3 percent of the College population.

Placement of graduates

As the leading centre for training on fish processing technology in The Philippines, the Department has noted a steadily maintained enrolment. Since 1958, a total of 74 graduates at the B.S. level have been trained (including other types of curricula related to Fish Processing Technology which were offered briefly in the past). In Appendix 5 the fields of work that graduates may enter was divided into six, as follows: research and/or extension; education (may include research); industry; other branches of fisheries; others, and unknown. The appendix shows that the graduates find employment and that they use their Fish Processing Technology education. However, the faculty is disappointed that only 3 percent of the graduates go into industry. We sincerely aim to produce more graduates for industry where we feel they are needed most. By the end of 1983 it is our goal that 80 percent of our graduates will be absorbed by industry. As one large patis factory owner mentioned recently, 'There is still so much to be done in The Philippine fish processing industry. We really need technical people like your graduates... but we need them on a long-term basis not on a one to two-year post-graduate, first job basis'. This then is the major problem of the Department at present: the proper placement of its graduates in the Philippine fishery industry.

The Department has adopted the following strategies in meeting the problem:

1. Realizing that the Practicum course (Fisheries 197) is the vital link of the Department to industry, one instructor has recently been appointed to coordinate students in this course so that they maximize the benefits obtained from it and at the same time the Department hopes to establish greater rapport with the fish processing industry.
2. Constant encouragement of students to enter industry.
3. Regular dialogue with industry through joint seminars, workshops, exhibits, etc.
4. Graduates who are fortunate to have at least modest capital are encouraged to put up their own cottage fish processing industry.

OTHER DEPARTMENTS

As mentioned earlier, the UP College of Fisheries has two other Departments, namely that of Marine Fisheries and of Inland Fisheries. The Department of Inland Fisheries, where more than half of the total College population is enrolled, handles instructional, research and extension programmes in aquaculture. An inventory of The Philippine aquatic flora and fauna is in progress along with research on cultivation of certain species of fish and blister pearls.

The College offers the graduate programme in aquaculture, not at the Diliman campus but at Leganes, Iloilo, in collaboration with SEAFDEC. The programme, institutionalized in 1974, had its first graduate in 1977. At present there are thirteen students working on masters' theses and 24 others enrolled in the academic courses.

At Leganes, Iloilo, the College maintains a Brackishwater Aquaculture Center (BAC) which started as a sub-division of the Inland Fisheries Project. This was supported for 5 years by the National Science Development Board but at the end of 1977 became an integral component of the University. The BAC pursues aquaculture

technology research with emphasis on pond fertilization techniques, soil suitability studies and natural fish food culture techniques. Results are published annually in the form of Technical Reports. The BAC also undertakes training programmes and extension services; the latter are linked with the BFAR.

At the Diliman station, the Institute of Fisheries Development and Research functions as the main research and extension arm of the College. While at BAC concentration is on aquaculture, the IFDR conducts research on all aspects of fisheries. In progress are investigations of traditional and non-traditional fishing grounds, in cooperation with PCARR.¹ This centres on the production potentials of important fishing grounds with emphasis on biology, oceanography and fishing methods. Studies on fish fermentation and fish protein concentrate are also undertaken in collaboration with other agencies.

REFERENCES

- Arroyo, P.T. *et al.*, Studies on rice-shrimp fermentation: *Balao balao*. Paper presented at the Symposium on
1977 indigenous fermented foods sponsored by UNEP/Unesco/ICRO in Bangkok, Thailand, November
21-26
- Magno-Orejana, F. and R.O. Juliano, Fish protetin concentrates prepared from some local species of fish by
1975 Ethano and Isopropanol extraction. *Bull.Natl.Res.Counc.Philipp.*, 30(1): March issue
- Santos, L.M., F.M. Magno-Orejana and M.N. Bautista, Utilization of by-products of milkfish processing;
1977 preparation of fish meal and silage. *Fish.Res.J.Philipp.*, 2(1):56-69

¹Philippine Council for Agriculture and Resources Research, Los Banos, Laguna, The Philippines

APPENDIX 1

*Bachelor of Science in Fisheries Curriculum
Major in Fish Processing Technology*

FIRST YEAR

<i>1st Semester</i>	<i>Units</i>	<i>2nd Semester</i>	<i>Units</i>
Botany 10 (General Botany)	5	Asian Civilization	3
English I and/or Filipino	6	English/Filipino	3
Mathematics 11 (College Algebra)	3	Chemistry 14 (Elementary Inorganic and Organic Chemistry)	5
Spanish I (Elementary Spanish)	3	Philippine History and Institution	3
MS 11 (ROTC)/Social Orientation I	(1.5/2)	Spanish II (Elementary Spanish)	3
Physical Education	(2)	MS 12 (ROTC)/Social Orientation II	(1.5/2)
Total	<u>17</u>	Physical Education	(2)
		Total	<u>17</u>

SECOND YEAR

English/Filipino	3	Fish 102 (Aquatic Fauna)	5
Fish 100 (General Fisheries)	3	Mathematics 14 (Plane Trigonometry)	3
Fish 111 (Aquatic Flora)	3	Physics 21 (Introductory Physics)	5
Social Science	3	Spanish 3 (Intermediate Spanish)	3
Zoology 11 (Fund of Zoology)	5	MS 22 (ROTC)	(1.5)
MS 21 (ROTC)	(1.5)	Physical Education	(2)
Physical Education	(2)	Total	<u>16</u>
Total	<u>17</u>		

THIRD YEAR

Fish 154 (Fisheries Microbiology)	5	Fish 120 (Analytical Chemistry)	5
Humanities I	3	Fish 122 (Statistics)	3
P I 100 (Life and Works of Rizal)	3	Fish 151 (Fish Processing I)	5
Spanish 20 (Readings in Spanish)	3	Fish 160 (Refrigeration)	3
Speech I (Fund of Speech)	3	Social Science	3
Total	<u>17</u>	Total	<u>19</u>

FOURTH YEAR^{1/}

Fish 110 (Organic Chemistry)	4	Fish 155 (Chem. Anal. of Aqua. Prod.)	4
Fish 152 (Fish Processing II)	5	Fish 157 (Fisheries Quality Control)	4
Fish 197 (Practicum)	0	Fish 159 (Fish Plant Management)	3
Fish 198 (Special Problem + Elective ^{2/})	6	Fish 170 (Fisheries Biochemistry)	4
or Fish 200 (Undergraduate Thesis)	4	Fish 171 (Advanced Fish Processing)	3
Fish 199 (Seminar)	1	Total	18
Total	14-16		

Total Number of Units + 135-137

1/ YCAP and Senior Graduate Seminar are additional subjects required for graduation

2/ Electives:

Accounting I (Fund or Management Accounting)	3 units
BA 101 (Management I)	3 units
Economics 11 (Introduction to Economics)	3 units
Fisheries 107 (Aquatic Invertebrates)	3 units
Fisheries 117 (Fish Diseases)	3 units
Fisheries 138 (Marine Ecology)	3 units
Fisheries 180 (Introduction to Oceanography)	3 units
Food Nutrition 11	3 units

DESCRIPTION OF COURSE		Prerequisite	Credit (Units)
Fisheries 100 General Fisheries	General survey of the fisheries resources, their production, utilization and conservation	None	3
Fisheries 102 Aquatic Fauna	A general survey of the aquatic animals with emphasis on commercial species	Zoology 11	5
Fisheries 107 Aquatic Invertebrates	Identification, habits, and distribution of aquatic invertebrates	Zoology 11	3
Fisheries 110 Organic Chemistry	Principles of organic chemistry and their application to fisheries	Chemistry 14	4
Fisheries 111 Aquatic Flora	Biology of aquatic plants and their significance to fisheries	Botany 10	3
Fisheries 117 Fish Diseases	Biology and control of fish diseases, parasites and pathogens	Fish 101	3
Fisheries 120 Analytical Chemistry	Principles and methods of qualitative and quantitative chemical analyses applicable to fisheries	Chemistry 14	5
Fisheries 122 Statistics	Statistical principles and methods applied in fisheries	Mathematics 11	3
Fisheries 138 Marine Ecology	The influence of the physico-chemical and biological properties of sea water on the distribution of marine organisms	Fish 181	3
Fisheries 151 Fish Processing I	Principles and methods of processing fisheries products	Chemistry 14 Fish 100 and 154	5
Fisheries 152 Fish Processing II	Continuation of Fish Processing I; practice in fish processing	Fish 151	5
Fisheries 154 Fisheries Microbiology	Bacteria, yeasts, moulds and parasites associated with fish; their characteristics and importance to fisheries	Botany 10 and Zoology 11	5
Fisheries 155 Chemical Analysis of Aquatic Products	Chemical composition of fish and fishery products	Fish 110 and 120	4
Fisheries 157 Quality Control	Quality assessment of fish and fishery products	Fish 120 and 154	4
Fisheries 159 Fish Plant Management	The organization and management of fish or food processing plants	Fish 152	3

Fisheries 160 Refrigeration	Principles and techniques of handling, icing and cold storage of fish and fishery products	Fish 154	3
Fisheries 170 Fisheries Biochemistry	Chemistry of proteins, lipids, carbohydrates, vitamins and enzymes with emphasis on fishes and fishery products	Fish 110	5
Fisheries 171 Advanced Fish Processing	Advanced methods of fish preservation, thermal processes and irradiation	Fish 152	3
Fisheries 180 Introduction to Oceanography	General survey of the seas as a marine environment	Fish 100	3
Fisheries 197 Practicum	Internship, field work or extension service in private or government establishments	Senior standing	None
Fisheries 198 Special Problem		Senior standing	3
Fisheries 199 Seminar	Undergraduate seminar on fisheries	Consent of the depart- ment Chairman	1
Fisheries 200 Undergraduate Thesis		Senior standing and consent of the depart- ment Chairman	4

APPENDIX 2

Diploma in Fisheries Curriculum
Major in Fish Preservation

FIRST YEAR

<i>1st Semester</i>	<i>Units</i>	<i>2nd Semester</i>	<i>Units</i>
Botany 10 (General Botany)	5	Chemistry 14 (General Inorganic and Organic Chemistry)	5
English I (Freshman English)	3	English/Filipino	3
Fish 100 (General Fisheries)	3	Fish 108 (Meteorology)	3
Fish 118 (Fishery Laws)	2	Zoology 11 (Fundamentals of Zoology)	5
Mathematics 11 (College Algebra)	3	MS 12 (ROTC)/Social Orientation II	(1.5/2)
MS 11 (ROTC)/Social Orientation I	(1.5/2)	Physical Education	(2)
Physical Education	(2)	Total	16
Total	16		

SECOND YEAR

Fish 102 (Aquatic Fauna)	5	Fish 151 (Fish Processing I)	5
Fish 110 (Organic Chemistry)	4	Fish 158 (Machinery and Appliances)	3
Fish 154 (Fisheries Microbiology)	5	Fish 170 (Fisheries Biochemistry)	4
Spanish I and II (Elementary Spanish)	6	Spanish 3 (Intermediate Spanish)	3
MS 21 (ROTC)	(1.5)	MS 22 (ROTC)	(1.5)
Physical Education	(2)	Physical Education	(2)
Total	20	Total	15

THIRD YEAR^{1/}

Fish 152 (Fish Processing II)	5	Fish 159 (Fish Plant Management)	3
Fish 153 (Minor Fishery Products)	3	Fish 197 (Practicum)	0
Fish 160 (Refrigeration)	3	Total	3
P I 100 (Life and Works of Rizal)	3		
Spanish 20 (Readings in Spanish)	3		
Total	17		

Total Number of Units = 87

1/ YCAP and Senior Graduate Seminar are additional subjects required for graduation

DESCRIPTION OF COURSES		Prerequisite	Credit (Units)
Fisheries 100 General Fisheries	General survey of the fisheries resources, their production, utilization and conservation	None	3
Fisheries 102 Aquatic Fauna	A general survey of the aquatic animals with emphasis on commercial species	Zoology 11	5
Fisheries 108 Meteorology	Elements of weather; forecasting methods and techniques, as applied to fisheries investigations	None	3
Fisheries 110 Organic Chemistry	Principles of organic chemistry and their application to fisheries	Chemistry 14	4
Fisheries 118 Fishery Laws	Laws affecting exploitation, protection and conservation of fishery resources; food and drug laws	None	3
Fisheries 151 Fish Processing I	Principles and methods of processing fisheries products	Chemistry 14 Fish 154 and 100	5
Fisheries 152 Fish Processing II	Continuation of Fish Processing I; Practice in fish processing	Fish 151	5
Fisheries 153 Minor Fishery Products	Methods of utilizing fishery by-products	Fish 151	3
Fisheries 154 Fisheries Microbiology	Bacteria, yeasts, moulds and parasites associated with fish; their characteristics and importance to fisheries	Botany 10 and Zoology 11	5
Fisheries 158 Machinery and Appliances	Machinery and appliances in fish processing	None	3
Fisheries 159 Fish Plant Management	The organization and management of fish or food processing plants	Fish 152	3
Fisheries 160 Refrigeration	Principles and techniques of handling, icing and cold storage of fish and fishery products	Fish 154	3
Fisheries 170 Fisheries Biochemistry	Chemistry of proteins, lipids, carbohydrates, vitamins and enzymes with emphasis on fishes and fishery products	Fish 110	4
Fisheries 197 Practicum	Internship, field work or extension service in private or government establishments	Senior standing	None

APPENDIX 3

*Academic Teaching Staff of the Department of Fish Processing Technology
College of Fisheries, University of the Philippines*

<i>Faculty Rank</i>	<i>Highest degree attained</i>	<i>Specialization</i>
Assistant Professor IV	Ph.D.	Food Science
Assistant Professor IV	B.S.	Pharmacy
Assistant Professor I	M.S.	Food Science
Assistant Professor I	M.S.	Pharm. Chemistry
	B.S.	Fish Technology
	Ph.D.	
	Candidate in Food Science College of Fisheries University of Washington, U.S.A.	
Assistant Professor I	B.S.	Fisheries Technology
	M.S.	
	Candidate	
Instructor III	B.S.	Fish Technology
	15 M.S. units in Food Science; on Government scholarship	
Instructor II	B.S.	Fish Technology
	9 M.S. units in Food Science	
Instructor II	B.S. Fish Technology — 6 M.S. units	
Instructor I	B.S. Fish Technology	
	9 M.S. units in Food Science	
Instructor I	B.S. Chemistry	
	9 M.S. units in Aquaculture	
Instructor I	B.S. Chemistry	

APPENDIX 4

Enrolment Summary
2nd Semester 1977-78

College of Fisheries
 University of the Philippines
 Diliman, Quezon City

Grand Total College Enrolment: 445

Old/old-returning	(Male/female: 217/222)	439
Transfer	(Male/female: 4/2)	6
Total male population		221
Total female population		224
Total Diploma course enrolment		243
Total B.S. course enrolment		165
Total M.S. course enrolment		37

BREAKDOWN OF ENROLMENT BY DEPARTMENT (BY YEAR LEVEL)

Fisheries Business Management

	1st	2nd	3rd	4th	Sub-total	Total	
Male	—	0	1	0	1	6	6
Female	—	0	3	2	5		

Fish Technology Department

Diploma	Male	2	0	0	—	8	56	
	Female	20	25	3	—	48		101
B.S.	Male	—	0	2	3	5	45	
	Female	—	0	11	23	40		

Inland Fisheries Department

Diploma	Male	31	29	13	—	73	146	
	Female	28	37	8	—	73		
B.S.	Male	—	10	7	25	42	84	267
	Female	—	6	12	24	42		
M.S.	Male					21	37	
	Female					16		

Marine Fisheries Department

Diploma	Male	23	14	4	—	41	41	
	Female	0	0	0	—	0		71
B.S.	Male	—	4	12	14	30	30	
	Female	—	0	0	0	0	30	

Total enrolment compared to preceding semester () 14 percent
 Total enrolment compared to preceding 2nd semester (even)

APPENDIX 5

Placement of B.S. Graduates of the Department of Fish Processing Technology
 (College of Fisheries, University of the Philippines)
 from 1958 to 1977

	<i>Number</i>	<i>Percentage of total</i>
1. Research and/or extension	37	51
2. Education (may include research)	13	18
3. Industry	2	3
4. Other branches of Fisheries	8	11
5. Other fields	10	14
6. Unknown	3	4
Total	73	101

ESTABLISHMENT OF POST-HARVEST TECHNOLOGY RESEARCH IN
THE MARINE FISHERIES RESEARCH DEPARTMENT,
SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTRE

by

Chief, Marine Fisheries Research Department
Southeast Asian Fisheries Development Centre
Changi Point, Singapore 17

Abstract

The paper describes the newly established post-harvest fish technology unit within the Marine Fisheries Research Development Centre, SEAFDEC, Singapore. The main elements of the work programme are listed.

INTRODUCTION

The Southeast Asian Fisheries Development Centre (SEAFDEC), established in 1968, is a regional organization formed under the auspices of the Ministerial Conference for the Economic Development of Southeast Asia. The Centre comprises three departments – the Marine Fisheries Research Department (MFRD) in Singapore, the Training Department in Thailand and the Aquaculture Department in the Philippines. The Centre is governed by a Council, the policy-making body, consisting of Directors representing the member countries namely Japan, Malaysia, the Philippines, Singapore, Thailand and Viet-Nam.

The Council of SEAFDEC, at its 8th Meeting in 1975, recognized the need for research and development of fishery post-harvest technology in the region and approved its inclusion into the activities of the MFRD; which are now as follows:

- (i) To develop the fishing grounds in Southeast Asia by experimental fishing;
- (ii) To carry out research into fishing gear, equipment, fishing methods and general handling of fish at sea in close cooperation with the Training Department;
- (iii) To conduct investigations of fisheries resources and research in fisheries oceanography for Southeast Asian countries;
- (iv) To conduct research and development of post-harvest fish technology;
- (v) To train research personnel and technicians; and
- (vi) To undertake such other activities as may be determined by the Council.

OBJECTIVES OF POST-HARVEST TECHNOLOGY DEVELOPMENT, SEAFDEC

The fundamental objective of post-harvest technology development in Southeast Asia is maximum utilization and minimum wastage of all available fish resources, thereby alleviating the problems of wastage and protein malnutrition in the region.

There are many other objectives which include better wet fish handling, storage and transport, improvement of traditional products and development of comminuted products. The programme will also conduct research related to maximum fish utilization, including underutilized species and fish waste. Quality control and inspection will also be covered. In addition a system for the smooth transfer of technology will be instituted.

INFRASTRUCTURE AND STAFF

In 1976-77, the MFRD made preparations for the implementation of the post-harvest technology programme. Two buildings provided by the Primary Production Department (PPD) of Singapore were renovated; a processing laboratory was completed and a microbiology/biochemistry laboratory will be available shortly. Essential equipment for the laboratories will be purchased this year to enable research work to commence.

Meanwhile the PPD has allocated three technically qualified staff to the MFRD, and accepted MFRD scientists for re-orientation and training in microbiological, chemical and organoleptic methods and techniques of analysis. Specialized training overseas and attendance of conferences and study tours will continue to be arranged for familiarization purposes, in order to build up the team working in this section.

Japanese experts are expected to strengthen the research work of the section. In due course, scientists and technicians from SEAFDEC member countries will be invited to participate in the research activities thereby effecting technology transfer for post-harvest technology development.

INDEXES

INDEX

AUTHOR INDEX

Mr. M.I. Abdulla
Agricultural Product Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. R. Abdulla
Agricultural Product Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. J. Abdullah
Agricultural Product Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mrs. Flor Abella
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Mr. M.B. Adebona
Department of Food Science and Technology
University of Ife
Ile-Ife
NIGERIA

Mr. M. Ahmed
Irradiation and Pest Control Research Institute
Bangladesh Atomic Energy Commission
Dacca-2
BANGLADESH

Mr. A.M.S. Alam
Irradiation and Pest Control Research Institute
Bangladesh Atomic Energy Commission
Dacca-2
BANGLADESH

Mr. M.A. Anenias
Department of Food Science and Technology
College of Agriculture
University of the Philippines at Los Banos
Laguna 3720
PHILIPPINES

Dr. Patricia Arroyo
Chairman
Department of Fisheries Technology
College of Fisheries
University of the Philippines
Diliman, Quezon City
PHILIPPINES

Mr. K.K. Balachrandran
Central Institute of Fisheries Technology
Cochin 682003
INDIA

Mr. C.D. Balista
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Mr. C.G. Beza
Department of Food Science and Technology
College of Agriculture
University of the Philippines at Los Banos
Laguna 3720
PHILIPPINES

Mr. A.D. Bhuiya
Irradiation and Pest Control Research Institute
Bangladesh Atomic Energy Commission
Dacca-2
BANGLADESH

Mr. N.S. Boyd
23 Arapiki Street
Nelson
NEW ZEALAND

Mr. H.A. Bremner
CSIRO Division of Food Research
Tasmanian Food Research Unit
Stowell Avenue
Hobart 7000
Tasmania
AUSTRALIA

Ms. Susan O. Canonizado
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Mr. P.K. Chakraborty
Central Institute of Fisheries Technology
Cochin 682003
INDIA

Mr. K.W. Chan
Fisheries Development Division
Agriculture and Fisheries Department
Canton Road Government Offices
393 Canton Road, 12th Floor
Kowloon
HONG KONG

Mr. A.K. Chatterjee
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore-570013
INDIA

Mr. K.W.J. Cheng
Fisheries Development Division
Agriculture and Fisheries Department
Canton Road Government Offices
393 Canton Road, 12th Floor
Kowloon
HONG KONG

Dr. M.N. Clifford
Grimsby College of Technology
Nun's Corner
Grimsby
South Humberside
UNITED KINGDOM

Mr. R.C. Cole
Tropical Products Institute
56-62 Grays Inn Road
London WC1 8LU
UNITED KINGDOM

Ms. Jean I. Cramer
Southwest Fisheries Centre
National Marine Fisheries Service, NOAA
Honolulu
Hawaii 96812
UNITED STATES OF AMERICA

Mr. H.B. Daud
Department of Agriculture
University of Tasmania
Hobart
Tasmania
AUSTRALIA

Mr. W.J.W. Daud
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. G.B. Debling
Grimsby College of Technology
Nun's Corner
Grimsby
South Humberside
UNITED KINGDOM

Mr. K. Devadasan
Veraval Research Centre
Central Institute of Fisheries Technology
Veraval 362265
INDIA

Mr. J.G. Disney
Tropical Products Institute
56-62 Grays Inn Road
London WC1 8LU
UNITED KINGDOM

Mr. C.T. Dwarakanath
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore-570013
INDIA

Mr. A. Edley
Massey University
Palmerston North
Wellington
NEW ZEALAND

Mr. M. Fierheller
 Environment Canada, Fisheries and Marine
 Halifax Laboratory
 Halifax
 Nova Scotia
 CANADA

Mr. N. Fusetani
 Laboratory of Marine Biochemistry
 University of Tokyo
 Bunkyo-ku
 Tokyo
 JAPAN

Mr. P.J. Gaiger
 Fisheries Development Division
 Agriculture and Fisheries Department
 Canton Road Government Offices
 393 Canton Road, 12th Floor
 Kowloon
 HONG KONG

Mr. J.G. Garbutt
 Grimsby College of Technology
 Nun's Corner
 Grimsby
 South Humberside
 UNITED KINGDOM

Mr. J. Glucksman
 A/Chief Biologist
 Kanudi Fish Research Station
 Department of Agriculture, Stock and Fisheries
 PAPUA AND NEW GUINEA

Dr. O.N. Gonzalez
 Scientific Research Supervisor
 Food Technology Research Division
 National Institute of Science and Technology
 Manila
 PHILIPPINES

Mr. K. Gopakumar
 Central Institute of Fisheries Technology
 Cochin 682003
 INDIA

Mr. C.V. Guerrero
 Fishery Economics and Information Division
 Bureau of Fisheries and Aquatic Resources
 Intramuros
 Manila
 PHILIPPINES

Ms. Gloria Guevarra
 Bureau of Fisheries and Aquatic Resources
 Cor. Real-Magallanes Street
 Intramuros
 Manila
 PHILIPPINES

Dr. K. Hashimoto
 Laboratory of Marine Biochemistry
 University of Tokyo
 Bunkyo-ku
 JAPAN

Mr. D. Hector
 Tropical Products Institute
 56-62 Grays Inn Road
 London WC1 8LU
 UNITED KINGDOM

Mrs. E.S. Heruwati
 Institute of Fishery Technology
 Jh. Karel S. Tubun
 Pos Palmerah
 Jakarta
 INDONESIA

Mr. A. Herzberg
 Fishery Technology Unit
 Department of Fisheries
 Ministry of Agriculture
 Haifa, P.O.B. 699
 ISRAEL

Mr. S. Hirao
 Tokai Regional Fisheries Research Laboratory
 Kachidoki 5-5
 Chuo-ku, Tokyo
 JAPAN

Mr. A. Hoffman
 Fisheries Department
 Botanical Garden
 Victoria, Mahe
 SEYCHELLES

Mr. Hooi Kok Kuang
 Marine Fisheries Research Department
 Southeast Asian Fisheries Development Center
 Changi Point, Singapore 17
 REPUBLIC OF SINGAPORE

Mr. G. Hopkirk
Department of Veterinary Science
Lincoln College
Canterbury
NEW ZEALAND

Mr. P. Howgate
Torry Research Station
P.O.B. 31, 135 Abbey Road
Aberdeen AB9 8DG
UNITED KINGDOM

Mr. S.M.S. Huda
Irradiation and Pest Control Research Institute
Bangladesh Atomic Energy Commission
Dacca-2
BANGLADESH

Mr. H.S. Huq
Division of Food Science and Technology
BCSIR Laboratories
Dacca
BANGLADESH

Mr. A.Z. Idrus
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. S. Ilyas
Director
Institute of Fishery Technology
Jh. Karel S. Tubun
Pos Palmerah
Jakarta
INDONESIA

Dr. M.S. Ismail
Department of Food Science and Technology
Universiti Pertanian Malaysia
Serdang, Selangor
MALAYSIA

Mr. K.M. Iyer
Central Institute of Fisheries Technology
Cochin 682003
INDIA

Mr. M.A. James
Central Institute of Fisheries Technology
Cochin 682003
INDIA

Mr. A. Kamari
Agricultural Product Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. J.F. Kefford
CSIRO Division of Food Research
P.O. Box 53
North Ryde 2112
New South Wales
AUSTRALIA

Mr. R. Kikuchi
Tokai Regional Fisheries Research Laboratory
Kachidoki 5-5
Chuo-ku, Tokyo
JAPAN

Mr. T. Kinumaki
Tokai Regional Fisheries Research Laboratory
Kachidoki 5-5
Chuo-ku, Tokyo
JAPAN

Mr. N.K. Lee
Fisheries Development Division
Agriculture and Fisheries Department
Canton Road Government Offices
393 Canton Road, 12th Floor
Kowloon
HONG KONG

Mrs. Anselma S. Legaspi
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Mr. A. Leung
Fisheries Development Division
Agriculture and Fisheries Department
Canton Road Government Offices
393 Canton Road, 12th Floor
Kowloon
HONG KONG

Mr. N.F. Lewis
 Biochemistry and Food Technology Division
 Bhabha Atomic Research Centre
 Bombay
 INDIA

Mr. A.M. Mabeza
 Department of Food Science and Technology
 College of Agriculture
 University of the Philippines at Los Banos
 Laguna 3720
 PHILIPPINES

Mr. P. Madhavan
 Central Institute of Fisheries Technology
 Willingdon Island, Cochin 682003
 INDIA

Dr. J.J. Matsumoto
 Department of Chemistry
 Sophia University
 Kioi-cho 7
 Chiyoda-ku, Tokyo
 JAPAN

Mr. T.A. McMeekin
 Department of Agriculture
 University of Tasmania
 Hobart
 Tasmania
 AUSTRALIA

Mr. L.S. Mendoza
 Department of Fisheries Technology
 College of Fisheries
 University of the Philippines
 Diliman, Quezon City
 PHILIPPINES

Mr. K.K.P. Menon
 The Tata Oil Mills Company Ltd.
 Fisheries Division
 Cochin
 INDIA

Ms. Zahara Merican
 Agricultural Products Utilization
 Malaysian Agricultural Research and Development
 Institute
 P.O. Box 202
 Serdang, Selangor
 MALAYSIA

Mr. P.J. Meynell
 Namiasi Fish Processing Laboratory
 P.O. Box 53
 Mangochi
 MALAWI

Mr. T.R. Miciano
 Department of Food Science and Technology
 College of Agriculture
 University of the Philippines at Los Banos
 Laguna 3720
 PHILIPPINES

Mr. R. Moeljanto
 Research Institute of Fishery Technology
 Jh. Karel S. Tubun
 Pos Palmerah
 Jakarta
 INDONESIA

Dr. M.N. Moorjani
 Central Food Technological Research Institute
 Cheluvamba Mansion
 Mysore-570013
 INDIA

Dr. D.J. Morgan
 B.P. Nutrition (Ireland) Ltd.
 Tallaght
 Co. Dublin
 IRELAND

Mr. A. Murray
 Fisheries Development Division
 Agriculture and Fisheries Department
 Canton Road Government Offices
 393 Canton Road, 12th Floor
 Kowloon
 HONG KONG

Mr. K.G.R. Nair
 Central Institute of Fisheries Technology
 Willingdon Island, Cochin 682003
 INDIA

Mr. M.R. Nair
 Central Institute of Fisheries Technology
 Willingdon Island, Cochin 682003
 INDIA

Mr. R.B. Nair
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore 570013
INDIA

Mrs. Linda Nicolaides
Tropical Products Institute
56-62 Grays Inn Road
London WC1 8LU
UNITED KINGDOM

Mr. T. Obileye
Nigerian Institute for Oceanography and
Marine Research
Lagos
NIGERIA

Dr. June Olley
Director
Tasmanian Food Research Unit
CSIRO
Stowell Avenue
Hobart 7000
Tasmania
AUSTRALIA

Dr. I.S. Pablo
Philippines Institute of Nutrition
Food Science and Technology
Philippine Women's University
Taft Avenue
Manila
PHILIPPINES

Dr. W. H. Parr
Tropical Products Institute
56-62 Grays Inn Road
London WC1 8LU
UNITED KINGDOM

Mr. T.S.S. Peiris
Research Division
Ministry of Fisheries
P.O. Box 1707
Colombo
SRI LANKA

Mr. P.A. Perigreen
Central Institute of Fisheries Technology
Willingdon Island, Cochin 682003
INDIA

Mr. V. Perovic
Industrial Processing Adviser
Pelagic Fishery Investigation on the Southwest
Coast Project
P.O. Box 1791
Ernakulam
Cochin 16
INDIA

Mr. F. Pili
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Dr. R.G. Poulter
Tropical Products Institute
56-62 Grays Inn Road
London WC1 8LU
UNITED KINGDOM

Mr. P.V. Prabhu
Central Institute of Fisheries Technology
Willingdon Island, Cochin 682003
INDIA

Mrs. R. Pruthiarenun
Fishery Technology Development Division
Department of Fisheries
Rajadamnern Avenue
Bangkok
THAILAND

Mr. S.V.S. Rao
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore 570013
INDIA

Mr. W. Rahimah
Agricultural Products Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

Mr. S. Rajalakshmi
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore 570013
INDIA

Mr. G. Ramanathan
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore 570013
INDIA

Mr. L.W. Regier
Environment Canada Fisheries and Marine
Halifax Laboratory
Halifax
Nova Scotia
CANADA

Mr. H.E. Rogers
Director
Education Section
Department of Primary Industry
Canberra, A.C.T. 2600
AUSTRALIA

Dr. S.F. Rubbi
Division of Food Science and Technology
BCSIR Laboratories
Dacca
BANGLADESH

Mrs. Bung-orn Saisithi
Fishery Technology Development Division
Department of Fisheries
Rajadamnern Avenue
Bangkok
THAILAND

Ms. Josephina G. Santos
Bureau of Fisheries and Aquatic Resources
Cor. Real-Magallanes Street
Intramuros
Manila
PHILIPPINES

Mr. L.M. Santos
Department of Fisheries Technology
College of Fisheries
University of the Philippines
Diliman, Quezon City
PHILIPPINES

Mr. G.E. Samuel
Integrated Fisheries Project
Ernakulam
Cochin 16
INDIA

Mr. C.R. Saraswati
Central Food Technological Research Institute
Cheluvamba Mansion
Mysore 570013
INDIA

Mr. J. Setabrahamana
Fishery Technology Development Division
Department of Fisheries
Rajadamnern Avenue
Bangkok
THAILAND

Mr. M. Shahidullah
Fisheries Technological Research Station
Chandpur
BANGLADESH

Ms. Niva Shapira
College of Nutrition and Domestic Science
Hebrew University of Jerusalem
Rèhovoth
ISRAEL

Mr. A.V. Shenoy
Central Institute of Fisheries Technology
Willington Island, Cochin 682003
INDIA

Mr. R.S. Shomura
Southwest Fisheries Centre
National Marine Fisheries Service, NOAA
Honolulu
Hawaii 96812
UNITED STATES OF AMERICA

Dr. E.C. Sison
Department of Food Science and Technology
College of Agriculture
University of the Philippines at Los Banos
Laguna
PHILIPPINES

Mr. P.J.I. Snell
68 Bramcote Lane
Wollaton
Nottingham
UNITED KINGDOM

Dr. J. Spinelli
U.S. Department of Commerce
Northwest and Alaska Fisheries Centre
Utilization Research Division
2725 Montlake Boulevard East
Seattle, Washington 98112
UNITED STATES OF AMERICA

Mr. J. Sumner
Department of Veterinary Science
Lincoln College, Canterbury
NEW ZEALAND

Mr. P.R. Tambunan
Institute of Fishery Technology
Jh. Karel S. Tubun
Pos Palmerah, Jakarta
INDONESIA

Mr. I.F. Tanudra
Department of Food Science and Technology
University of the Philippines
Los Banos College, Laguna
PHILIPPINES

Mr. K. Tipkong
Fishery Technology Development Division
Department of Fisheries
Rajadamnern Avenue
Bangkok
THAILAND

Mr. A.P. Valsan
Bombay Research Centre
Central Institute of Fisheries Technology
Bombay 5
INDIA

Mr. S. Varga
Environment Canada, Fisheries and Marine
Halifax Laboratory
Halifax, Nova Scotia
CANADA

Mr. R. Venkataraman
Veraval Research Centre
Central Institute of Fisheries Technology
Veraval 362265
INDIA

Mr. S. Vidot
Fisheries Department
Botanical Gardens
Victoria, Mahe
SEYCHELLES

Mr. N.D.C. Wilson
Massey University
North Palmerston
Wellington
NEW ZEALAND

Mr. H.S.H. Yuan
Southwest Fisheries Centre
National Marine Fisheries Service, NOAA
Honolulu, Hawaii 96812
UNITED STATES OF AMERICA

Mr. A.M. Zain
Department of Food Science and Technology
Universiti Pertanian Malaysia
Serdang, Selangor
MALAYSIA

Mr. M.B. Wojtowicz
Environment Canada, Fisheries and Marine
Halifax Laboratory
Halifax, Nova Scotia
CANADA

Mr. Q.L. Yeoh
Agricultural Product Utilization
Malaysian Agricultural Research and Development
Institute
P.O. Box 202
Serdang, Selangor
MALAYSIA

SUBJECT INDEX

A

- Acceptability of fish products: 308, 361, 395, 446, 454, 565, 602.
- Algae — use as food: 412
- cultivation: 412
- Animal feed from fish: 61, 86, 375, 488, 527, 543, 554, 578.
- Antioxidants: 568
- Aspergillus*: 304, 529.
- Available lysine: 243, 501.
- Availability of ice: 50

B

- Bacteriological quality: 146, 172, 187, 197, 224, 393.
- Bagoong: 27, 248, 507.
- Beche de mer: 75
- Belachan: 9, 55, 445, 572.
- Blackspot in shrimp: 75
- Blanching: 341.
- Bombay duck: 340
- Brining: 371, 393
- Browning discolouration: 343
- Bulk storage of iced fish: 146, 193
- 'Burnt' tuna: 213
- Budu: 7, 304, 445, 572.
- By-catch — utilization: 2, 14, 62, 89, 288, 377, 515, 581.
 - percentage in trawl: 91, 228
 - composition: 86, 581.
 - use as animal feed: 515

C

- Canning: 18, 28, 40, 56, 83, 272, 303, 435.
- Carcass composition: 158, 378.
- Carrier boats: 4, 147.
- Cincalok: 7, 445, 576
- Chemical composition
 - fish: 286, 291, 458, 530, 574.
 - algae: 412
- Chemical tests for quality: 170, 187, 194, 198, 205, 224, 288, 361, 449.
- Chilled brine: 14
- Chlorine — use on froglegs: 154
- Ciguatera: 417

- Codex Alimentarius: 455
- Cohesiveness of fish balls: 582
- Containers for fish: 31
- Cooperatives: 4, 39
- Cooking in brine: 394
- Cured products: 74, 370, 388, 390, 434, 572.
- Cuttlefish: 102

D

- Decontamination of froglegs: 76, 154
- Dehydro-irradiation: 340
- Delay prior to icing: 14, 157, 193, 197
- Dermestes*: 310, 348, 401
- Dimethylamine: 290, 370, 459
- Dinogunellin: 418
- Dipterid maggots: 312, 530
- Disinfestation: 312
- Dried fish — method: 26, 54, 237, 250, 308, 310, 388, 444, 472
 - blowfly in : 347
 - use of pyrethrum: 311, 347
 - rancidity in: 330, 565
 - in IPFC countries: 375, 444, 468, 572
- Dried mussels: 75, 102
- Drip loss in frozen prawns: 278
- Dry/salting: 371, 401, 444, 559, 577.

E

- Earwig infestation: 312
- Education in fisheries: 633, 664
- Elasticity of fish noodle: 384
- Extension services: 608, 652, 655

F

- Fermented fish: 9, 27, 55, 444, 508, 560, 572.
- Filletting yield: 159, 437
- Fish balls: 3, 444, 561, 577, 581
 - briquettes: 527
 - burgers: 3
 - cakes: 28, 165, 562, 581
 - disinfestation: 310
 - fingers: 256
 - freshness: 136, 269, 229, 449

inspection: 431, 433, 449, 462
 live: 2, 12, 128
 markets: 31, 425, 439
 maws: 516
 meal: 8, 20, 28, 57, 61, 102, 375, 510, 515.
 — quality: 70, 376, 510.
 — from by catch: 86, 375, 515, 572.
 noodles: 382
 — soup: 382
 oil: 19, 262, 377, 515.
 — composition: 262
 — content: 68, 158, 262, 496, 530.
 paste: 7, 23, 55, 101, 445, 507, 562, 572.
 per capita consumption: 105, 303, 439
 poisoning: 416
 protein concentrate: 492, 559
 quality: 224, 157, 169, 182, 193, 197, 204, 224,
 229, 288, 431, 433, 449.
 sauce: 7, 25, 55, 101, 248, 304, 444, 508, 560.
 sausage: 3, 28, 444, 561
 silage: 19, 57, 165, 376, 490, 513, 527, 543, 554,
 559, 578.
 spoilage: 136, 146, 157, 193, 197, 204, 224.
 waste: 517, 61, 68, 73, 375, 515, 527, 543,
 559, 572.

Fishery cooperatives: 4, 73, 435, 608

Fisheries development: 2, 12

 education: 633, 659, 664

 extension: 608, 652, 655

 training: 608, 633, 652, 655, 659, 644.

Free fatty acids: 291, 362

Freshness index: 412, 136, 169, 229, 449.

Froglegs: 136, 5, 15, 42, 75, 154.

Frozen fish: 52, 74, 330, 436.

 — storage: 52, 157, 204, 255, 459.

G

Glazing: 53, 75

Grading of fish: 146, 198, 229, 454

Green tuna: 213

Gutted fish -iced storage: 157

H

Halophilic bacteria: 389

Handling of fish: 31, 50, 197, 425

Hasa-hasa: 248

Hedonic scales: 457

Heko: 572

Histamine: 215

Honey combing: 215

Hypoxanthine: 170, 187, 194, 197, 331, 459

I

Ice/fish ratios: 58, 198

Iced storage: 136, 146, 186, 193, 197, 205, 219,
 224, 229

 — effect of size delay and
 gutting: 146, 194

Ice-availability: 49

Ikan bilis: 304, 444, 574

Inosine monophosphate: 205

Insecticides — use on fish: 312, 347

Insect infestation: 310, 347, 401, 527

Inspection: 431, 433

Iodine values: 465

Irradiation: 248, 310, 340, 401

J

Jellyfish: 102, 18, 572

K

Kamaboko: 267, 388, 503

Katsuobushi: 7

Keropok: 7, 444, 578

Krill: 559

L

Larvae of insects: 314

Liquid fish protein: 375, 492, 527

Live fish marketing: 2

M

Mariculture: 128, 130, 425

Marketing: 4, 18, 31, 74, 425, 439, 462, 468

 — information: 439, 462, 468

 — costs: 439, 468

 — wholesale: 439, 468

Marine toxins: 416

Meat/bone separator: 159, 243, 254, 267, 380, 382,
 388, 559, 582

Mechanical drying: 83, 322

Metabisulphite: 75

Mesopelagic fish: 418, 559

Minced fish: 128, 243, 254, 267, 380, 382, 388, 559, 581

Middlemen: 14, 4, 34, 468

Microbiology (see bacteriology)

Moulds in spoilage: 341, 389, 406, 479

Monosodium glutamate: 577

Mussels: 101, 354

N

Noodles: 382

O

Organoleptic quality assessment: 159, 171, 187, 194, 198, 205, 224, 229, 249, 258, 282, 331, 342, 355, 361, 402, 449

P

Packaging: 27, 317, 383, 388, 393, 445

Patis: 10, 27, 248, 304, 444, 508

Paralytic shellfish poisoning: 418

Pekasam: 542

Peptone: 520

Peroxide value: 331, 170, 465, 402

pH and quality: 205

Poisonous fish: 416

Polyphosphates: 75, 382, 577

Prawns (see shrimp)

Prawn waste (see shrimp)

Product development: 102, 288, 304, 360, 505, 380, 390, 444, 436, 559

Puffer fish: 416

Pupae of insects: 313

Q

Quality assessment

— bacteriology: 146, 170, 187, 191, 204, 213, 224

— biochemical: 146

— control/standards: 21, 57, 77, 431, 433, 449, 462, 513, 515

— fish meal: 56, 463, 467

— of iced fish: 14, 61, 510, 515, 146, 157, 170, 193, 204, 224

R

Rancidity: 54, 69, 330, 566

Refrigerated sea water: 50, 186

'Red tide': 420

Rhodamine B: 445

S

Salmonella: 42, 78, 154

Salt quality: 39, 508, 565

Salting: 18, 444, 27, 39, 54, 73, 82, 370, 392, 438, 559, 581

Salted/dried fish: 559, 572, 81, 310, 388, 390, 401, 444

Salt/fish powders: 559

Salted jelly fish: 577

Saxitoxin: 419

Seaweed: 412

Shark fins: 75, 515

— skins: 515

— liver oil: 18, 40, 515

Shrimp/prawn —bacteriology: 52

— by catch: 52, 288, 543, 559, 31, 14, 86, 581

— canned: 435, 575

— handling: 52, 86

— paste: 101, 444

— processing: 52, 74

— trawling: 86

— waste: 575, 520

Smoked fish: 55, 165, 242, 248, 465

— methods: 27, 49, 388

— effects of iced/frozen storage: 157

Silage: 18, 57, 376, 513, 543, 165, 578, 544

Sorbic acid: 388, 393

Spoilage rates: 136, 204, 224, 229

Spoilage by moulds: 318, 340, 393, 401, 340, 449

Sun drying: 73, 210, 438, 390, 401, 340, 559, 507

Surimi: 267, 388, 492

Surugatoxin: 419

Storage of fish: 121, 157, 193, 204

T

Taint due to fish silage: 527

Taste panel quality assessment: 171, 187, 194, 198, 205, 288, 331, 361, 224, 384, 395, 588

Tetrodotoxin: 416

Thiobarbituric acid: 170, 205, 391, 361, 393

Thermal processing: 360

Total volatile bases: 170, 205, 224, 393, 404, 459, 370, 331, 361

Torry meter: 171, 187, 198, 229, 460
Toxins from marine organisms: 416
Transportation of fish: 2, 34, 50, 81, 197, 146
Trash fish: 115, 572, 578
Trimethylamine: 290, 342, 371, 392, 434, 459
Triangle tests: 451
Training: 607, 633, 352, 655, 659, 664

U

Utilization of fish waste: 68, 76, 303, 375, 572, 489
 small pelagic fish: 304, 360, 527, 560

V

Vitamin A: 13, 377, 515
Vitamins in fish oil: 377
Volatile basic nitrogen: 342, 371, 459

W

Waste utilization: 68, 76, 375, 489, 527, 559, 572
Water activity: 389, 564

INDEX OF FISH NAMES

A

Abalone: 415
 Acanthuridae: 417
 Amberjack (*Seriola aureovittate*): 417
 Anchovy (teri): 2
Anodontostoma spp.: 27
 Apoginidae: 86
 Ariidae: 86, 581
Arius sona: 288
Auxis thazard, sinaing na tulingan: 248

B

Balistidae: 86
 Bangos, milkfish, *Chanos chanos*: 34
 Barracouta, (*Thyrsites atun*): 554
 Bass, sharp toothed, (*Pristipomoides typus*),
 ikan kerisi bali or ikan merah: 198
 Big-head (*Aristichthys nobilis*): 425
 Blenny, northern, (*Stichaeus grigorjewi*): 418
 Bolti (see *Tilapia nilotica*)
 Bombay duck (*Harpodon nehereus*): 43, 330, 340
 Bream, black, sea, (*Mylio macrocephalus*) 128
 Bream, gold-lined, sea, (*Rhabdosargus sarba*): 128
 Bream, sea, (*Evynnis cardinalis*): 528
 Bream, threadfin, (unspecified): 54, 382
 Bream, threadfin, (*Nemipterus japonicus*): 288, 437
 520
 Bream, white, sea (*Mylio berda*): 128
 Bream, yellowfinned, sea, (*Mylio latus*): 128

C

Cabazon (*Scorpaenichthys marmoratus*): 418
Caesio spp., ian sulit: 581
Caesio erythrogaster: 3, 581
 Carangidae: 86, 417
Caranx spp.: 148
Caranx equula (crevalle): 528
 Carcharhinidae: 417
 Cardinal fish (*Apogon quadrifasciatus*): 528
 Carp (unspecified): 15, 24, 81, 265
 Carp (*Barbus carnaticus*) 364
 Carp, calbasu: 364
 Carp, (*Catla* spp.): 44
 Carp, common (*Cyprinus carpio*): 425
 Carp, grass, (*Ctenopharyngodon idella*): 425

Carp (*Labeo gonius*): 312
 Carp (*Mrigal* spp.): 44
 Carp (*Rohu* spp.): 44, 364
 Carp silver: 15
 Carp, silver (*Hypophthalmichthys* spp.): 425
 Castor oil fish (*Lepidocybium flavobrunneum*): 418
 Castor oil fish (*Ruvettus pretiosus*): 418
 Catfish (unspecified): 146, 364, 437, 44, 81
 Catfish (*Arius* spp.): 288
 Catfish, ikan duri: 53
 Catfish, (*Tachysurus* spp.): 437, 255
 Cephalopoda: 86, 559
Chanos chanos (see milkfish)
Chirocentrus (unspecified): 146
Chirocentrus dorab: 255
Chirocentrus dorab: golok-golok, ikan parang:
 3, 8, 229
 Clam: 434, 437, 4, 75, 419
Clupea, spp.: 360
Clupea spp., tamban: 68
Clupea leiogaster, ikan tamban beluru: 9
 Clupeidae: 86
 Clupeids: 581
 Coal fish: 489
 Cod, flower (*Epinephelus fucoguttatus*): 128
 Cod, (*Gadus macrocephalus*): 380
 Cod, (*Gadus morhua*): 172, 332
 Cod, peacock rock, (*Cephalopholis argus*): 128
 Copepods: 489
 Crab (unspecified): 18, 75, 86, 115, 380
 Crab, blue, (*Neptunus pelagicus*): 249
 Crab, xanthid (*Zosimus aenus*): 419
 Crevalle (*Caranx, equula*): 27, 528
 Croaker (unspecified): 27, 528
 Croaker (*Pseudosciaena* spp.): 257
Cryptopterus spp., lais: 3
 Cucumber fish (*Chlorophthalmus nigripinnis*): 299
 Cuttlefish: 27, 41, 51, 75, 102, 572
Cynoglossus lingua, lidah, sebelah: 229

D

Decapterus spp.: 16
Decapterus macrosoma: 27
Decapterus russellii, ikan selayang: 8, 67

Diodontidae: 86
 "Diving fish?": 418
 Dorosomatinae: 86
 Drepanidae: 86
 Drummer, large-tailed, (*Kyphosus lembus*): 128
 Dussimieriinae: 86

E

Echineidae: 86
 Eel (unspecified): 146
 Eel european, (*Anguilla anguilla*): 151
 Eel, moray, (*Cymnothorax javanicus*): 417
 Eel, japanese, (*Anguilla japonica*): 151
 Eel, "wild", short-finned, (*Anguilla australis*): 151
 Emperor, long-nosed (*Lethrinus miniatus*): 128
 Emperor, sprangled, (*Lethrinus nebulosus*): 128
 Emperor, variegated, (*Lethrinus variegatus*): 128
 Emperor, yellow-striped, (*Lethrinus ornatus*): 128
 Engraulidae: 86
 Ephippidae: 86
 Duphausids: 489
 Euselachii: 86
Euthynnus alleteratus, tongkol: 229

F

Fellona: 148
 Filefish, (*Alutera scripta*): 418
 Filefish, (*Monacanthus* spp.): 528
 Filefish, (*Stephanolepis cirrhifera*): 380
 Fish maws: 38, 73
 Flagfish (*Goniistius zonatus*): 128
 Flatfish (unspecified): 194, 86, 581
 Flatfish (*Rhombosolea plebia*): 187
 Frog, costa rican, (*Atelopus* spp.): 417
 Froglegs: 75, 83, 154, 436, 15, 42
 Fusilier, yellow-tailed, (*Caesio cuning*): 169

G

Gastropod (*Babylonia japonica*): 419
 Gerreidae: 72
 Globe fish (*Spheoroides rubripes*): 380
 Goatfish three banded, (*Parupeneus trifasciatus*): 128
 Goatfish, yellow, (*Pseudupeneus barbarinus*): 128
 Goatfish yellow, (*Upeneus cyclostomus*): 128
 Goby (unspecified): 23
 Goby (*Govius criniger*): 417
 Goldfish: 425

Granter (*Pomadasys argyreus*): 288
 Grenadier (unspecified): 581
 Grouper (unspecified): 27, 52, 128
 Grouper, black-tipped red, (*Epinephelus fasciatus*): 128, 157
 Grouper (*Epinephalus chlorostigma*): 157
 Grouper (*Epinephelus flavocaeruleus*): 157
 Grouper (*Epinephelus microdon*): 417
 Grouper, flag-tailed, (*Cephalopholis urodelus*): 128
 Grouper, green, (*Epinephelus tauvina*): 128
 Grouper, high finned, (*Cromileptes altivelis*): 128
 Grouper, kohloris, (*Epinephelus kohlori*): 128
 Grouper, long finned, (*Epinephelus megachir*): 128
 Grouper, lunnar-tailed, (*Variola louti*): 128
 Grouper, mud, (*Epinephelus brunnus*): 128
 Grouper (*Plectropomer maculatum*): 169
 Grouper, red, (*Epinephelus akaara*): 128
 Grouper, rock (*Epinephelus fasciomaculatus*): 128
 Grouper, yellow, (*Epinephelus awoara*): 128
 Grunt, head, (*Pomadasys hasta*): 128
 Guppy: 416

H

Hairtail (*Trichiurus haumela*): 528
 Hake (unspecified): 299
 Hake, blue: 489
 Half beak (*Hermiraphus sajori*): 380
 Halibut, indian, (*Isettodes erumei*): 437
Haplochromis spp., Haka: 347
 Herring (unspecified): 507
 Herring (*Clupea harengus*): 333, 370
 Herring, round, (*Dussumieria basseltii*): 528
 Herring, (*Sardinella fimbriata*), tunsoy: 250
 Herring, wolf, (*Chirocentrus dorab*): 577
 Hilsa: 42, 248
 Hilsa (*Hilsa hilsa*): 262
Hilsa ilisha: 42, 82

J

Jawfish: 51
 Jellyfish: 17, 512
 Jewfish (*Otolithus* spp.): 325
Johnius pseudosciaena soldado, gelama: 209

K

Kingfish, butterfly: 215
Kishinoella tonggol, tongkol: 209
 Krill (unspecified): 559
 Krill, antarctic: 499

L

- Labridae: 417
 Lactariidae: 86
Lactarius (unspecified): 75
Lactarius lactarius: 325
 Lagocephalidae: 86
Lagocephalus lunaris lunaries: 416
 Lantern fish: 416
Lates spp.: 348
 Laver: 380
 Leiognathidae: 86
Leiognathus (Unspecified): 46, 255, 325, 528, 582
Leiognathus splendens: 582
 Lethrinidae: 417
Lethrinops spp., chisawasawa: 347, 565
 Lizard fish (unspecified): 28
 Lizard fish (*Saurida* spp.): 528
 Lizard fish (*Saurida tumbil*): 288
 Lobster (unspecified): 16, 28, 36, 42, 75, 433, 86
Lutianus (unspecified): 581
Lutianus sebae, vara vara: 157
Lutianus bohar: 157
 Lutjanidae: 86, 417

M

- Mackerel (unspecified): 27, 40, 75, 115, 141, 149, 216, 401, 498
 Mackerel, blue, (*Scomber australasicus*): 187
 Mackerel, chub, (*Rastrelliger brachysoma* bleeker): 169, 330
 Mackerel, chub, (*Rastrelliger neglectus*): 332
 Mackerel, horse: 364, 498
 Mackerel, horse, (*Caranx*, spp.): 16, 225
 Mackerel, indo-pacific, kembung: 2
 Mackerel, (*Rastrelliger branchysoma*), hasa hasa: 248
 Mackerel, (*Rastrelliger kanagurta*): 229, 250, 325, 340, 364, 437
 Mackerel, scad, (*Decapterus pinnulatus*): 216
 Mackerel, (*Scomber scombrus*): 172, 255
 Mackerel, slimy, (*Scomber japonicus*): 528
 Mackerel, spanish, (*Scomberomorus commersoni*): 577
 Mackerel, spanish, (*Scomberomorus guttatus*): 16, 577
 Mackerel, spanish, tenggiri: 2
 Mackerel, striped: 401
 Mahimahi (*Coryphaena hippurus*): 216
 Marlin, black, (*Makaira indica*): 216
 Marlin, blue, (*Makaira nigricans*): 216
 Marlin, striped, (*Tetrapturus audax*): 216

- Megalopidae: 86
 Myctophids: 299, 489
 Milkfish (unspecified): 15, 35, 44, 249
 Milkfish, bangus: 611
 Milkfish (*Chanos, chanos* forskal): 24, 35, 44, 249, 204
 Milkfish, freshwater: 395
 Morwong (*Cheilodactylus macropterus*): 296
 Mullet (unspecified): 24, 32, 44
 Mullet, grey, (*Mugil cephalus*): 425
 Mullidae: 86
 Muraenesocidae: 86
Muraenesox spp.: 581
 Muraenidae: 417
 Mussel (unspecified): 4, 23, 75, 434, 437
 Mussel (*Perna canaliculus*): 354
 Mussel (*Mytilus californianus*): 419

N

- Nannygai (*Centroberyx affinis*): 296
 Nemipteridae: 86
Nemipterus spp. 581
Nemipterus japonicus: 288, 325, 520, 582
 Newt, Californian, (*Taricha torosa*): 417

O

- Oyster: 24, 354, 434, 437

P

- Palythoa tuberculosa*: 418
 Pargo, red, (*Chrysophrus major*): 128
 Parrot fish, blue-barred, (*Scarus ghobban*): 128
 Parrot fish, blunt-headed, (*Scarus macrorhinus*): 128
 Parrot fish, jordan's, (*Scarus jordani*): 128
 Parrot fish, long-nosed, (*Scarus longiceps*): 128
 Parrot fish, red-toothed, (*Scarus erythrodon*): 128
 Parrot fish, (*Scarus gibbus*): 417
 Parrot fish, tattooed, (*Scarus fasciatus*): 128
 Parrot fish, yellow finned, (*Scarus frenatus*): 128
 Pearl: 434
 Pearl spots: 44
 Perch (unspecified): 44, 146
 Perch (*Nemipterus japonicus*): 325
 Perch, red-eyed, (*Psammoperca waigiensis*): 128
 Perch, sea, (*Lates calcarifer*): 128
 Platycephalidae: 86
 Pollack (unspecified): 299, 493
 Pollack, Alaska: 267, 498

Pollack, Alaska, (*Theragra chalcogramma*): 267, 380
 Polynemidae: 86
 Pomadasyidae: 86
Pomadasys spp.: 582
Pomadasys argyreus: 582
Pomadasys hasta: 582
 Pomfret (Unspecified): 42, 76
 Pomfret, black: 146
 Pomfret, silver: 146
 Ponyfish (*Leiognathus splendens*): 288
 Prawn (unspecified): 24, 42, 73, 86, 149, 375, 425, 434, 516, 572, 582, 611
 Prawn brackish-water: 14
 Prawn, brown: 52
 Prawn, green: 52
 Prawn, non-penaeid: 255
 Prawn, pink: 52
 Prawn, tiger-stripe: 52
 Prawn, white: 52
 Priacanthidae: 86
Pristipomoides typus, merah, kerisi bali: 229
 Puffer fish (*Lagocephalus lunaris*): 416
 Puffer fish (*Tetraodon* spp.): 528
Puntius spp.: 14

R

Rabbit fish, fuscous, (*Siganus fuscescens*): 128
 Rabbit fish, gold spotted, (*Siganus sutor*): 128
 Rabbit fish (*Siganus* spp.): 128
Rastrelliger kanagurta, kembong (see Mackerel)
 Rawas: 146
 Ray: 86
 Redfish: 489
 Ribbonfish (*Trichiurus* spp.): 255
 Ribbonfish (*Trichiurus lepturus*): 288
 Rock fish, (*Caesio erythrogaster*)
 ekor kuning: 3
 Round scad (unspecified): 27, 392, 507
 Round scad (*Decapterus macrosoma*), galonggong: 392

S

Sail fish (*Istiophorus platypterus*): 216
 Sardine (unspecified): 27, 61, 75, 498, 507, 636, 544
 Sardine, golden, (*Sardinella* spp.): 525
 Sardinella spp.: 27, 360
 Sardinella eba: 370
 Sardinella fimbriata: 229, 507
 Sardinella longiceps: 40, 507,
 Sardine, oil: 73, 330, 516
 Sardine, oil, lemuru: 2, 141
 Sardine, oil, (*Sardinella longiceps*): 40, 332, 436, 272

Sardine, (*Sardina pilchardus*): 250
 Sardine, (*Sardinella fimbriata*), tamban sisek: 229
 Sardine (*Sardinella jussieu*): 528
 Sardine (*Sardinella perforata*): 528
 Sardine, white, kowala coral: 257

Saurida spp.: 86, 581
Saurida tumbil: 581
 Saury: 215
 Scad, big-eyed: 28
 Scad (*Decapterus* spp.): 528
 Scad (*Decapterus marnadsi*): 528
 Scad, layang: 2
 Scad (*Trachurus* spp.): 528
 Scad (*Trachurus japonicus*): 528
 Scallops (unspecified): 3, 27, 354, 434,
 Scallop (*Anadora* spp.): 16
 Scaridae: 417
Scarus bicolor: 128
Scarus janthochir: 128
Scarus limbatus: 128
 Sciaenid: 255
 Sciaenidae: 86, 360, 582
 Scomberomoridae: 86
 Scombridae: 86
 Scorpaenidae: 86
 Seer (unspecified): 75, 146, 215
 Seer fish, spotted: 330
 Seer (*Scomberomorus guttatus*): 437
Selaroides leptolepis, selar kuning: 67
 Serranidae: 86, 417
 Shad, gizzard, (*Clupanodon punctatus*): 528
 Shark: 27, 325, 470, 375, 516, 40, 81, 86, 141, 255
 Shark (*Carcharhinus menisorrh*): 417
 Shark, fin: 75, 516, 40
 Shrimp (unspecified): 3, 14, 36, 40, 66, 75, 102, 115, 141, 146, 255, 273, 380, 525, 431, 434, 543, 559, 572
 Shrimp, (*Acetes* spp.), udang baring, udang geragok: 8
 Shrimp, (*Acetes erythrurus*): 573
 Shrimp, (*Acetes indicus*): 573
 Shrimp, (*Acetes japonicus*): 573
 Shrimp, (*Acetes sibogae*): 573
 Shrimp, (*Macrobrachium dolichodactylus*): 82
 Shrimp (*Macrobrachium lamarrie*): 82
 Shrimp (*Macrobrachium malcomsonii*): 83
 Shrimp (*Macrobrachium rosenbergii*): 83
 Shrimp (*Macrobrachium villosimanus*): 83
 Shrimp (*Penaeus* spp.): 250
 Shrimp (*Penaeus indicus*): 340
 Shrimp, tiny, (*Parapenaeopsis stylifera*): 340
 Sillaginidae: 86
 Silverbelly: 517

- Silverbelly (*Leiognathus* spp.): 255, 325
 Skate: 370
 Skipjack (see tuna).
 Slimeheads: 581
 Slipmouth (unspecified): 28, 528
 Slipmouth (*Leiognathus bindus*): 528
 Slipmouth (*Leiognathus insidiator*): 528
 Slipmouth, small, *Leiognathus*: 507
 Snapper (unspecified): 7, 47, 128
 Snapper, banded red, (*Lutjanus lineolatus*): 128
 Snapper, black and white, (*Macolor niger*): 128
 Snapper (*Chrysophrys auratus*): 187
 Snapper, humpback, red, (*Lutjanus gibbus*): 128
 Snapper, John's, (*Lutjanus johni*): 128
 Snapper, mangrove, (*Lutjanus argentimaculatus*): 128
 Snapper, one-banded, (*Lutjanus vitta*): 128
 Snapper, red: 16
 Snapper, red, ikan merah: 45
 Snapper, red, (*Lutjanus bohar*): 128
 Snapper, 157, 417
 Snapper, red, (*Lutjanus sanguineus*): 128
 Snapper, russels, (*Lutjanus russelli*): 128
 Snapper, two spotted, (*Lutjanus bohar*): 128
 Snapper, white blotched, (*Lutjanus rivulatus*): 128
 Snapper, yellow, (*Lutjanus kasmira*): 128
 Soldier fish, yellow striped, (*Holocentrus ruber*): 128
 Sole: 255
 Spearfish, shortbill, (*T. angustirostris*): 216
 Sphyraenidae: 86, 417
 Sponges: 434
 Sprat (*Spratus spratus*): 250
 Sprat (*Stolephorus* spp.): 250, 325
 Spritatelloides japonicus: 507
 Squid: 75, 104, 42
 Squid (*Notodarus hawaiiensis*): 216
 Squid (*Sepia esculenda*): 380
 Squilla: 256, 518
 Squilla (*Orato squilla nepa*): 518
 Stolephorus spp. (unspecified): 2, 10, 27, 51, 255, 303, 325, 360, 507, 527, 572
 Stolephorus indicus: 507
 Stromateidae: 86
 Stromatid fish (*Centrolophus* spp.): 419
 Stromatid fish (*Cubiceps gracilis*): 419
 Stromatid fish (*stromateus maculatus*): 419
 Surgeon fish (*Ctenochaetus striatus*): 418
 Sweetlip, banded, (*Plectorhycus curvieri*): 128
 Sweetlip barliquim, (*Plectorhycus chaetodonoides*): 128
 Sweetlip black, (*Plectorhycus nigrus*): 128
 Sweetlip, orange-spotted, (*Plectorhycus flavo-maculatus*): 128
 Sweetlip (*Plectorhycus* spp.): 128
 Synodontidae: 86
 T
 Talang (*Chorinemus lysan*): 528
 Tetraodontidae: 416
 Theraponidae: 86
Thrissocles spp.: 255
 Tigerfish (*Therapon jarbua*): 128
 Tilapia spp., (unspecified): 24, 242, 348, 465
 Tilapia lidole, Chambo: 564
 Tilapia mossambica: 304
 Tilapia nilotica, nila, boliti: 4, 393
 Tilapia (*Sarotherodon mossambica*): 237
 Tilapia (*Tilapia aureous*): 242
 Trevallies, selar: 2
 Triacanthidae: 86
 Trichiuridae: 86
 Trichiurius spp.: 581
 Trichiurius haumela: 86
 Trichiurius lepturus: 581
 Trout, leopard coral, (*Plectropona leopardus*): 128, 437
 Trout, leopard coral, (*Plectropona maculatum*): 128
 Tuna (unspecified): 3, 16, 27, 30, 75, 115, 434, 545
 Tuna, albacore, (*T. aluhunga*): 213
 Tuna big eye, (*T. obesus*): 213
 Tuna, bluefin, (*Thunnus thynnus*): 196
 Tuna, kawakawa, (*Euthynnus affinis*): 213
 Tuna, little, (*Euthynnus affinis*): 250
 Tuna skipjack, (*Katsuwonus pelamis*): 213, 250
 Tuna, yellowfin, (*Thunnus albacares*): 213
 Turtle: 75
 Tusk fish, black-spotted, (*Choerodon schoenleinii*): 128
 Tusk fish, yellow-checked, (*Cheilinus undulatus*): 128
 U
 Upeneus spp.: 86
 Uranoscopidae: 86
 V
 Variola louti: 157
 W
 Wahoo (*Acanthocybium solandri*): 216

- Whitebait (*Stolophorus* spp.): 250
- Whitefish (*Lactarius* spp.): 255
- Wrasse, double-headed, (*Cheilinus undulatus*): 128
- Wrasse, scarlet-breasted, (*Cheilinus fasciatus*): 128
- Wrasse, thick lipped, (*Hemigymnus melapterus*): 128

Y

- Yellowbelly (*Nemipterus bathybius*): 36
- Yellowtail (*Seriola quinqueradiata*): 420

The full Proceedings of this Session consist of three Sections of which Section I and II have already been published.

Section I contains the Report of the Session and the Indo-Pacific Fishery Commission Symposium on Fish Utilization Technology and Marketing in the IPFC Region. Section II is the Report of the First Session of the IPFC Standing Committee on Resources Research and Development (SCORRAD). Section III contains the papers presented at the Symposium on the Development and Utilization of Inland Fishery Resources.

Copies are distributed free to the Council's Member Governments and to Institutions, etc. on an exchange basis.



Printed through the courtesy of the
Philippine Bureau of Fisheries and
Aquatic Resources (BFAR)

P. O. Box 623
Arcadia Building 860 Quezon Avenue
Quezon City, Metro Manila, Philippines